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DIPHTHERIA

ITS

NATURE AND TREATMENT

VARIETIES AND LOCAL EXPRESSIONS

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P R E F A C E.

NEARLY twenty years having elapsed since any English work has appeared on the subject of Diphtheria, and medical views as to the nature and treatment of the disease having undergone considerable development during that period, it has appeared to me that a short sketch of the affection, from one who has had considerable opportunities of studying it, might be of interest, and possibly of use, to the profession.

A malady which, under various names, has existed for so many thousand years, which has been so widely diffused, and which has caused such dire havoc, must always be of interest to the student of medicine.

The victims of the disease have generally been children of tender years, but vigorous youth has frequently fallen under the scourge, and anxious parents have too often suffered for their watchful solicitude. In its attacks it shows no respect for distinctions of sex or social position. Rich and poor, strong and weak, alike fall beneath its onslaught, and its ravages are greater in scattered villages than among the crowded denizens of our great cities.

Sanitary science has not yet learnt to bar its progress, and, in some instances, arrangements—professedly hygienic—have even appeared to favour its entrance.

Although epidemics of this disease have not influenced the progress of civilization like those plagues of the middle ages, which more especially attacked adults, yet the historian may chronicle the fact that the illustrious Washington died from the disease in the course of a few hours; that the unfortunate Empress Josephine, whose family had previously shown a marked susceptibility to the affection, quickly succumbed to it; and that—since these pages were in type—our own country has been plunged into profound grief through this fatal pestilence.

Long shall we all deplore the loss of the gentle and accomplished Princess whose soothing ministrations had so often alleviated the sufferings of others.

M. M.

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affections, but simple inflammatory diseases, distinctly pelli-
cular affections, and lesions of innervation have been so
confused together by the earlier writers on medicine, that
there is little or no advantage to be gained by collecting
the numerous synonyms employed by different authors at
various times. The term *diphtheritis* was originally sug-
gested by Bretonneau, who, observing that the disease was
differentiated from other similar maladies by the formation
of a false skin or membrane, coined the word *diphtherite*
from the Greek διφθέρα, a skin or parchement, and ite
from ἵρης (εἶμι), hasty, impetuous, the well-known termi-
nation used in medicine to imply inflammation. Trousseau
subsequently modified the word to *diphthérie*, in order to get
rid of the etiological doctrine of inflammation which the affix
indicated, and the term *diphtheria* was adopted by our Regis-
trar-General. Names indicative of inflammation still hold
their ground, however, amongst German and Italian writers.

The presenece of a membraniform deposit in the fauces
seems to have been regarded as a morbid condition, attended
with considerable danger to life, from the earliest times. At
a time nearly coeval with that of Pythagoras, D'hantavare,
an Indian physician, had included in his "System of Medi-
cine"¹ a description which is very suggestive of diphtheria.
The writer mentions a disease in which "an increase of
phlegm and blood causes a swelling in the throat, charac-
terized by panting and pain, destroying the vital organs, and
incurable."² He also says, "a large swelling in the throat,
impeding food and drink, and marked by violent feverish
symptoms, obstructing the passage of the breath, arising

¹ This systematic work on medicine is written in Sanskrit, by
D'hantavare, and compiled by his pupil, Susruta. A Latin transla-
tion, by F. Hessler, was published at Erlangen in 1844, and is in the
British Museum; it has the following title: "Susrutas Ayurvédas;
id est Medicinæ Systema a Venerabili D'hantavare Demonstratum a
S. Discipulo Compositum." It is from this translation that the
quotations in the text are taken.

² Ibid. p. 202.

from phlegm combined with blood, is called 'closing of the throat.'" ¹ It has been supposed by some that Hippocrates² recognized the disease more than two thousand years ago, but it is extremely doubtful whether his observations really referred to diphtheria. On the other hand, "the Syriac ulcer," described by Aretæus³ (probably in the time of Augustus), is generally considered to have more points of resemblance to the diphtheria of to-day than any other disease of antiquity. Describing ulcers on the tonsils, Aretæus tells us that some are mild and harmless, while others are pestilential and fatal. The former—which are common—are clean, small, and superficial, and are unaccompanied either by pain or inflammation. The latter—which are rare—are extensive, deep, putrid, and covered with white, livid, or blackish concretion. Aretæus then goes on to depict the way in which, in fatal cases, the disease progresses, stating that "if it extends rapidly to the chest through the windpipe, the patient dies on the same day by suffocation." About a century later Galen⁴ referred to the expectoration of a membranous tunic from the pharynx, but did not actually describe diphtheria. Cœlius Aurelianus,⁵ at the end of the third century, describes the "barking" sound of the voice and its occasional complete extinction, the stridulous breathing and lividity of face. His reference to the defective articulation sometimes present, and to the passage of fluids into the nose in swallowing, probably refer to the paralytic symptoms of the disease. It is supposed

¹ Ibid. p. 205. The following passage may also possibly describe diphtheria:—"Si quis valde lugens semper suspirat, interruptam vocem, et aridum solutumque sonum habet in respirationis viis, phlegmate oblitis, hic morbus propter suspirium vocis occisor cognoscendus est."—Ibid. 206.

² "De Dentitione."

³ Aretæus: "De Causis et Signis Acutorum Morborum," lib. i. cap. 9.

⁴ "De Locis Affectis," lib. i. c. 1.

⁵ "De acutis Morbis," lib. iii. c. 2. et c. 4.

that the Askara frequently mentioned in the Talmud¹ as a fatal epidemic was, in fact, diphtheria. Rashi, the learned commentator of the Talmud and Old Testament, remarks with reference to the Askara that "sometimes it breaks out in the mouth of a man and he dies from it." He further observes that "sudden death ensues from suffocation." Aetius, of Amida² in the sixth century delineated the disease as presenting white and ash grey spots in the pharynx, slowly ending in ulceration. There is no record of the disease from that period until the sixteenth century, when its occurrence at Alkmaer in Holland in 1557 was described by Peter Forest;³ its features were most accurately sketched by Von Woerd⁴ a few years later.

It is not until we arrive at comparatively modern times that we find diphtheria forcing itself upon the attention of physicians as a distinct disease. Baillou, a distinguished French physician, who flourished in the last half of the sixteenth century, was the first to publish an accurate description. It is in his writings that we find the first definite mention of a false membrane.⁵ A few years later, the same appearance was noted by several Spanish physicians as occurring in the course of an epidemic disease, which they

¹ The word "Askara" (אִסְכָּרָא or אִסְכָּרָה) means literally "closure," and is allied to the word Sakar (סָכַר) "to shut up" or "to close." Askara is frequently used in the Aramaic dialect of the Babylonian and Jerusalem Rabbins. Its effect is compared to strangulation, and its danger consists in its being communicable to others. Some modern lexicographers translate "Askara" by "Croup". Buxtorf, in the Basle edition of the Talmud (1639), renders it by "Angina." I am indebted to the well-known Hebrew scholar—the Rev. A. Löwy—for most of my information on this subject.

² Petrabibl. Sermo. viii. cap. 46. Basil, 1535.

³ Obs. lib. vi., De febribus, &c.

⁴ Chronik durch Sebastian Franken Von Woerd. bis auf die Regierung des Grossmechtigsten Kayser's Carlo V., in das Jahr. 1531, anfangen, &c., 1585. (Cited by Zahn: "Beiträge zur Pathologischen Histologie der Diphtherie." Leipzig, 1878).

⁵ Gulielmi Ballouii: "Epidemiorum et Ephemeridum." Geneva, 1576, libri ii. "Pituita lenta contumax quæ instar membranæ cujusdam arteriæ asperæ erat obtenta."

minutely portrayed under the name of "garrotillo." The best description is that of Villa Real (1611), who states that he has seen a thousand times (*millies vidi*) in patients, at the first onset of the disease, a white matter in the fauces, gullet, and throat. He adds that this matter is of such nature that if you stretch it with your hands it appears elastic, and has properties like those of wet leather—facts which he noticed, not only by observing the matter coughed up by the living, but also by the examination of it in the dead.¹ The descriptions of Fontecha² (1611) and Herrera³ (1615) are less satisfactory, as containing no account of post-mortem appearances; but they are valuable in so far as they confirm the fact of the prevalence of garrotillo in Spain between the years 1581 and 1611. Some years subsequently to the latter date diphtheria appears to have prevailed as a fatal epidemic in Naples and other parts of Italy. Sgambatus⁴ tells us that in 1617 a highly contagious affection of the throat appeared, attacking the children of rich and poor alike, and often sweeping away whole families. In referring to this epidemic, some years later, Severino⁵ for the first time clearly described diphtherial paralysis. The same epidemic is depicted by Nola⁶ and Carnevale,⁷ and the latter asserts that it was identical with that which had been prevailing in Spain, under the popular name of "garrotillo."

¹ *Johannis de Villa Real: "De Signis, Causis, Essentiâ, Prognostico et Curatione Morbi Suffocantis."* Compluti, 1611, p. 35, et seq.

² *"Disputationes Medicæ," &c. opus Doctoris Fontecha.* Compluti, 1611.

³ *"De Essentiâ, Causis, Notis, Præsagio, Curatione et Præcautione Morbi Suffocantis Garrotillo Hispane Appellati," auctore Doctore Herrera.* Matriti, 1615.

⁴ *"De Pestilente Fauæium Affectu, Neapoli Saviente Opusculum," auctore Andrea Sgambato.* Neapoli, 1620.

⁵ *"De Pedanehone Maligna," &c. Neapoli, 1643.*

⁶ *"De Epidemieo Phlegmone Anginoso Grassante Neapoli," Franciscus Nola.* Venetiis, 1620.

⁷ *"De Epidemico Strangulatorio Affectu in Neapolitam urbem Grassanti et per regna Neapolis et Siciliæ Vagante," auctor Jo Baptista Carnevale.* Neapoli, 1620.

The writings of Cortesius¹ (1625) render it nearly certain that the same disease extended somewhat later to Sicily. A membrane in the throat, which could be readily torn away, is distinctly described as being one of its symptoms. The works of Alaymus² (1632) and of Actius Cletius³ (1636) have also been quoted as affording corroboratory evidence of the prevalence of diphtheria in Italy and Sicily during the seventeenth century. Medical literature is then silent on the subject for nearly a century, but after that time follows a rapid series of observations from different parts of Europe. In 1713 Dr. Patrick Blair,⁴ in a letter to Dr. Mead, described a disease as "the croops," which he says "was epidemic and universal" at Coupar Angus, and which was no doubt diphtheria. In 1748 Ghisi⁵ observed an epidemic of the disease in Palermo, and noticed the paralytic phenomena; and in the same year Dr. Fothergill⁶ described an outbreak of scarlet fever, in which the throat-symptoms often led to a fatal result. Most of these cases were undoubtedly examples of œdematous inflammation, but it is possible that some were of the nature of secondary diphtheria. In 1749 Marteau de Grandvilliers⁷ described an outbreak of the disease in Paris, and the elder Chomel,⁸ in detailing the symptoms, accurately depicted diphtherial paralysis. In 1750 the formation of a membraniform concretion in the

¹ *Johannis Baptistæ Cortesii: "Miscellaneorum Medicinæ Decades Denae."* Messanae, 1625.

² *Marci Antonii Alaymi: "Consultatio pro Ulceris Syriaci nunc Vagantis Curatione."* Panhormi, 1632.

³ *"De Morbo Strangulatorio," opus Aetii Cletii Siguini.* Roma, 1636.

⁴ *"Observations in the Practice of Physic," &c.* London, 1718.

⁵ *"Lettere Mediche del Dottore Martino Ghisi."* Cremona, 1749.

⁶ *"An Account of the Sore Throat attended with Ulcers,"* by Dr. John Fothergill. London: Fifth Edition, 1769.

⁷ *"Dissertation Historique sur l'espèce de Mal de Gorge Gangréneux qui a régné parmi les Enfants l'année dernière."* Paris, 1749.

⁸ *"Dissert. Hist. sur l'aspect du Mal de Gorge Gangréneux," &c.* Paris, 1749.

throat is distinctly described by Dr. John Starr,¹ as occurring in an epidemic in Cornwall, and in 1757 a similar observation was made by Willeke² in Sweden. In the same year Dr. Huxham³ described an epidemic which had been prevalent at Plymouth, in which some of the cases were examples of scarlatina anginosa, whilst others were undoubtedly cases of secondary diphtheria.

At length the attention of the profession was fully called to the peculiar characteristics of diphtheria by Dr. Francis Home,⁴ who, in 1765, under the name of croup described an acute affection of the larynx and trachea, coming on insidiously, attended with the formation of a membrane in the pharynx and air passages, and often causing death by suffocation. Home appears to have been the first to notice the quick, weak pulse which is often present in the disease. The treatise of the Scotch physician attracted the attention of Dr. Michaelis⁵ of Göttingen, who, in an essay published in 1778, confirms and supplements his observations. From time to time epidemics of scarlatina were described in which the throat symptoms predominated, and some of these have been wrongly supposed to have been examples of diphtheria. The next record of the disease comes from America, where in 1789 Dr. Samuel Bard,⁶ of Philadelphia, published a minute account of "an uncommon and highly dangerous distemper" which had recently proved fatal to many children in New York. Dr. Bard was a careful and painstaking observer, and his monograph contributed very considerably to the accuracy of contemporary

¹ "Philosophical Transactions." 1752, vol. xlv. p. 435.

² "Dissertation Medica de Anginâ Infantum in Patriâ Recentioribus annis Observatâ." Willeke, Upsalæ, 1764.

³ "A Dissertation on the Malignant Ulcerous Sore Throat," 1757.

⁴ "An Inquiry into the Nature, Cause, and Cure of Croup," by Francis Home, M.D. Edinburgh, 1765.

⁵ "De Angina Polyposâ sive Membranceâ." Göttingen, 1778.

⁶ "Transactions of the American Philosophical Society." Philadelphia, 1789.

knowledge with regard to diphtheria. In 1798¹ another American physician, Dr. John Areher, published an interesting paper, and recommended a new remedy for the disease. In the year 1801 Dr. Cheyne,² a British physician, published an essay in which he distinctly portrays diphtheria under the name of *cynanche trachealis* or croup. He recognizes it as the same disease as that referred to by Baillou, Ghisi, Home, and Michaelis, and gives a minute description and plates of the false membrane found in the trachea after death. In 1802 Dr. Cullen,³ the well-known professor of the practice of physic in the University of Edinburgh, gave a description of *cynanche trachealis* in which we cannot fail to recognize the diphtheria of modern times. For many years after its appearance Dr. Cullen's work was the favourite text-book on medicine with all British practitioners and students, and its author, therefore, may claim the credit of having rescued diphtheria from the region of discussion and monographs, and of having given it a fixed and recognized position in medical science. The disease, however, was evidently still a rarity in the British Isles, and it probably only occurred in the isolated form. In France the case was otherwise; the disease was well known as a frequent visitor, under the name of croup, and having caused the death of some of the members of the Imperial family in 1807, a prize was offered by Napoleon I. for the best essay on the subject. This led to the publication of the valuable works of Albers, Jurine, and Royer-Collard—works which were worthy predecessors of the classical memoirs of Bretonneau.⁴ The latter owed their

¹ "An Inaugural Dissertation on *Cynanche Trachealis*, commonly called Croup or Hives." Philadelphia, 1798.

² "Essays on the Diseases of Children, with Cases and Dissections," by John Cheyne, M.D. Edinburgh, 1801.

³ "First Lines of the Practice of Physic," by William Cullen, M.D. Edinburgh, 1802, vol. i., p. 219.

⁴ "Des Inflammations Spéciales du Tissu Muqueux et en particulier de la Diphthérie." Paris, 1826. The first mention of Bretonneau's memoir, which was read before the Academy, appeared in Guersant's

origin to an alarming outbreak of the disease at Tours in the latter part of the year 1818. The epidemic was carefully investigated by Bretonneau, who published an account of his researches in 1826. An accurate description of "diphtherite" was given by Dr. Abererombie in a work published in 1828.¹ The disease appears to have prevailed in an epidemic form in Edinburgh in the year 1826, but otherwise it was by no means a common affection in this country. In fact, after the brief notoriety conferred on diphtheria by the works of Bretonneau, the disease seems to have passed from the minds of English physicians, and its very existence to have been almost forgotten. It still occurred from time to time in all parts of Europe, but it did not excite attention to any great extent until the year 1853, when it broke out with some violence in Paris. In 1855 an epidemic at Boulogne, which was especially fatal to the resident English, excited considerable attention, and during the two following years serious outbreaks were reported from different parts of France. The first case of the greatest epidemic of the disease which, as far as is known, has ever occurred in this country, was imported from Boulogne to Folkestone in 1856,² but it was not till 1858 that the disease attained very alarming proportions in this country. Spreading, as it seemed, from many independent centres, it raged as a wide-spread and fatal epidemic during 1859, and continued very seriously prevalent during

"Diet. de Méd." t. ii. vi. and xix., 1821—1823, but his essay was not issued till three years later. This memoir, as well as those subsequently published by the same author, was translated (together with other selected essays by different French physicians) by Dr. R. H. Semple, for the New Sydenham Society in 1859. The work is entitled "Memoirs on Diphtheria from the writings of Bretonneau, Guersant, Trousseau, Bouchut, Empis, and Daviot." Mr. Chatto added a very complete bibliography to this work, which the author has found of great service.

¹ "Pathological and Practical Researches on the Diseases of the Stomach," &c., by John Abererombie, M.D. Edinburgh, 1828.

² "Reports of the Medical Officer of the Privy Council." No. ii. London, 1860.

the three following years.¹ Since that time diphtheria has not appeared in England with anything like the same malignancy; it still claims several thousand victims annually, but its invasions are for the most part circumscribed in area, and both in this country, and on the Continent, only expand from time to time into limited epidemics.²

¹ The best accounts of the epidemics of that period are those of Mr. Ernest Hart: "Diphtheria," London, 1859, and Mr. Netten Radcliffe: "The Recent Epidemic of Diphtheria,"—"Trans. of the Epidem. Soc." February, 1862. The main features of this epidemic, as it appeared in London, are graphically depicted by Sir William Jenner in his two lectures on "Diphtheria: its Symptoms and Treatment," London, 1861, and a more detailed description of the disease has been given by Dr. Headlam Greenhow in his classical monograph "On Diphtheria," London, 1860.

² This short historical sketch is only intended to give a general idea of the occurrence of the disease at previous periods. For an exhaustive treatment of the subject the reader is referred to the following works, as well as those mentioned in subsequent notes:—Deslandes: "L'Angine Couenneuse et le Croup, considérés sous le rapport de l'état local qui les constituent, sont ils identiques?" "Journ. des Progrès des Sc. Méd." t. i., p. 152, 1827. Fuchs: "Historische Untersuchungen über Angina Maligna und ihr Verhältniss zu Scharlach und Croup." Würzburg, 1828. Geddings: "On Pseudomembranous Inflammation of the Throat." "Amer. Journ. of Med. Sci." vol. xxiv., p. 73. 1839. (These three authorities are cited by Chatto: Loc. cit.) Jacobi's article on Diphtheria, and Rauchfuss' contribution to Croup—the former contained in the second volume, and the latter in the third volume (second part) of Gerhardt's magnificent work "On Diseases of Children," Tübingen, 1877-78—contain the most complete bibliography since the end of the last century.

CHAPTER II.

ETIOLOGY.

THE *exciting* cause is a specific contagium, and those cases which appear to originate *de novo*, probably always arise from the virus—often long dormant and forgotten—of previous cases. Tender age is the principal *predisposing* cause, but the accidental existence of pharyngeal catarrh, or of any disease which lowers the system, probably increases individual receptivity. Family constitution also often exercises an unfavourable influence.

The natural history of the contagium has not yet been elucidated. Some information has been obtained as to the atmospheric conditions and temperature under which the poison exists and flourishes, but considerable uncertainty exists as to the laws which govern its development and effect its diffusion. The mode or modes also in which the disease-producing virus enters the system, and its period of incubation, have not yet been accurately determined. These various points will now be considered in detail.

The Natural History of the Contagium.—The contagious principle has not been isolated, although it is highly probable that it consists of minute particles of matter, which are capable of floating in the atmosphere, and attaching themselves to rough surfaces (*see* Mode of Diffusion). The doctrine has been put forth by Oertel, Hueter, Nassiloff, Letzerich, and others, that a minute fungus is the essential contagium. The views of these authors will be referred to in detail in treating of the pathology, and it is sufficient to state here that the observations are not sufficiently conclusive to warrant

us in considering that the essence of the disease has yet been discovered. Low vegetable organisms probably play an important part in the propagation of the disease, but the exact relation between the disease and the organisms has not as yet been made out. The experiments of Oertel, Letzerich, and others, if uncontradicted, would only show that micrococci are an invariable concomitant of diphtheria; that they are the sole or even the main agent in its causation cannot as yet be considered proved. Dr. Maelagan¹ has, however, clearly shown that "the germ theory" explains all the phenomena of the specific fevers, and in a matter, which at present is beyond *inductive* proof, analogy is of the highest value. For a further consideration of this subject, the reader is referred to the section on Pathology.

In considering the etiology of the disease, it is most important to determine whether it can originate *de novo* or not. Although the disease so often arises in connection with bad drainage, foul habits, and impure water supply; and although it is so often impossible to trace the remotest channel of contagion, yet the whole tendency of sanitary science is opposed to the doctrine of the spontaneous origin of specific diseases.² It must not be forgotten that in those cases where the disease appears to enter the system through the use of drinking water contaminated with excrementitious matter, the specific germs of the disease, derived from persons previously suffering from it, may have found their way into the water. I have frequently known the disease occur suddenly in remote country districts, where careful inquiries have failed to discover the smallest evidence of infection, but similar phenomena are often observed in connection with scarlatina and small-pox—diseases which no one would now attribute to a

¹ "The Germ Theory," &c. London, 1876.

² Simon: "Sixth Report on Public Health," quoted by Dr. Aitken: "The Science and Practice of Medicine." Sixth Edition. Vol. i. p. 338. See also Sir Thomas Watson's article on "The Abolition of Zymotic Disease"—"Nineteenth Century," May, 1877.

spontaneous origin.¹ A very remarkable instance of the apparently spontaneous origin of the disease was observed last year by Dr. Semon, at a small health resort, called "Bad Fusch" in the Tyrol. The place, consisting of only two houses, is situated at an elevation of from 3,000 to 4,000 feet above the sea, and is celebrated for its fresh air and pure water. In one of these houses a little girl, five years of age, who had left Vienna five weeks previously, was suddenly attacked with diphtheria, which was subsequently followed by paralysis. The visitors consisted almost entirely of tourists, ascending the high mountains in the neighbourhood. Although other children had been playing with the little girl up to the day on which she was attacked, no other case of the kind occurred. It need scarcely be said that the outbreak of the disease in this case may, however, also be explained in accordance with the theory of contagion.

Climatic and Atmospheric Conditions under which the Contagium Lives and Flourishes.—The disease exists in almost every country, but it is most common in temperate climates. The contagium lives under ordinary atmospheric conditions, but it is probable that dampness favours its development. It occurs in the tropics, but does not appear to have been noticed in the Arctic regions. It seems likely that the germs may remain dormant, *external to the body*, for a considerable period, and may only develop under the stimulus of some particular atmospheric conditions,² or when a suitable nidus presents itself. In making statistical inquiries, with reference to the registration of disease in sub-districts, Dr. Thursfield³ found in certain isolated hamlets and houses where in recent years he had been called upon to

¹ Dr. Kelly also states as the result of his experience as the sanitary officer of a wide tract of country, that diphtheria often appears in lonely outlying places, far away from any main road; and often no history of contagion can be traced at all.—"Second Annual Report of the Combined Sanitary Districts of West Sussex."

² Sanné: "Traité de la Diphthérie." Paris, 1876, p. 231.

³ "Lancet," vol. ii. 1878. Nos. vi. vii. viii.

investigate cases of diphtheria, that at intervals of five, ten, fifteen, twenty-five, thirty, and even more years, there had been previous outbreaks of fatal sore throat. An instance is recorded by Dr. William Squire¹ in which the virus remained latent eleven months, and then led to the development of the disease when a person occupied the room in which a case of diphtheria had previously occurred. I have known the poison to remain dormant for four, seven, and fifteen months, and in one instance for three years, and then again to become active. From the above considerations the vitality of the disease-germs would seem to be considerable.

In Great Britain the disease has generally been prevalent in those parts of the country where the rainfall is great, in villages situated in valleys, or in places where there is not sufficient fall to get rid of the surface drainage, but it has also been frequently met with, and shown great epidemic persistency, in high, dry, and exposed situations.

The disease is much more common in rural than in urban districts. Whether, however, this fact points to the greater humidity which prevails in the country, or to the absence of proper drainage, is not at present certain. According to Dr. Thursfield,² whose experience as a sanitary inspector extends over twelve hundred square miles, "with a population of rather more than two hundred thousand, of which rather more than one hundred thousand are rural, the number of fatal cases of diphtheria in the rural portion is nearly three times that in the urban portion." The same author remarks that whatever conditions seem to promote fungoid growth, would appear to favour the incidence and persistence of the disease, and the explanation of the comparative immunity of towns may be the presence of something in their atmosphere inimical to such growth.

Until recently the extension of the disease was considered to

¹ Reynolds' "System of Medicine," vol. i. p. 379.

² Loc. cit.

be independent of season, but the observations of Wibmer¹ and Thursfield² tend to show that it prevails more extensively during the winter months than at other periods of the year. Many severe epidemics have, however, steadily raged through the whole round of the year in spite of the most varied changes of weather and temperature.

Mode of Diffusion.—Considerable difference of opinion exists as to the mode in which the poison is diffused. The disease may be imparted to others by a person actually, or lately, suffering from it, but the extreme difficulty of effecting *artificial* implantation would tend to show that direct contagion is rare. From this fact it would seem probable that the contagium, when set free from the affected individual undergoes further development (as in the case of cholera and typhoid fever), which increases its disease-producing properties. It is asserted that the poison may be conveyed by a person not actually affected by the disease. Dr. Thursfield³ has reported a very remarkable case, in which a woman living in an infected house, but not at any time suffering herself, walked a mile or two and crossed a ferry to visit a friend. She only remained a short time in the house, but sufficiently long to leave the germs of diphtheria, which broke out a day or two afterwards. This, however, is such an exceptional example, that the possibility of the malady having arisen from other sources must be borne in mind. In one instance I have known the disease caught from a patient who had entirely recovered from it four months previously, but whether it was conveyed by the person or the clothes of the individual, it was impossible to determine. In solitary cases the contagium does not usually assume a virulent form,

¹ "Statistischer Bericht über die Münchener Epidemien, 1864—69," quoted by Oertel: Ziemssen's "Cyclopædia," vol. i. p. 590; also "Deutsch. Arch. f. kl. Med." 1870, vol. viii. p. 242; "Experimentelle Untersuchungen über Diphtheritis," p. 346. See also Rauchfuss: Loc. cit. p. 150.

² Loc. cit.

Loc. cit.

and proper measures are almost invariably successful in confining the disease to a limited area. The distance at which the contagious principle can operate as a rule appears to be more limited than is the case in typhus or small-pox. Thus I have known an instance in which seven children were affected in a house which had a residence on each side of it, and a third opposite at a distance of only twenty-four feet. Although in all these buildings there were young children, no other case of diphtheria occurred. Other similar illustrations of this fact are on record.¹ Under certain circumstances, however, the diffusive powers are increased, and, as appears to be the case in epidemics of influenza, the poison may be wafted over extensive tracts of country.

The germs of diphtheria appear to have an affinity for the walls of rooms, and, according to some observers, may attach themselves to clothes and articles of furniture.² It is probable that by the introduction of such things the poison is often diffused.

Manner in which Poison Enters the System.—The poison may be received into the system (a) by direct implantation; (b) through the circumambient air; (c) through the water that is drunk, or the food that is eaten. Further, it is possible that it may be occasionally introduced by inoculation, either with portions of false membrane or with the blood of a patient suffering from the disease.

(a) The melancholy deaths of Valleix and Henri Blache,³ show that the disease may occasionally originate from direct implantation. M. Sée⁴ has reported a case of the same character, in which a woman suckled a child affected with diphtheria. In consequence her own child, which she was nursing at the same time, contracted labial diphtheria, and communicated it to the mother, who frequently kissed her

¹ Thursfield: Loc. cit.

² Sanné: Op. cit.

³ Trousseau: "Clin. Lectures," New Syd. Soc. Trans. vol. ii. p. 497.

⁴ "Bull. de la Soc. Méd. des Hôp." t. iv. p. 378.

infant. An instance of direct implantation has been related by Professor Bossi,¹ in which a greyhound was seized with symptoms akin to those of diphtheria four days after swallowing the excrement of a child who died of that disease; after death a membranous exudation was found on the animal's fauces.²

(b) The contagium which exists in the secretions and exhalations of the sick, may pass into the air and find its way directly into the healthy organism by absorption through the lungs, or through the mucous membrane of the throat; or the secretions of the sick may pass into drains, and sewer gas holding the disease germs in suspension, may be afterwards inspired.

(c) The poison may be conveyed through food or water (or other fluid used for drinking purposes), as in the analogous case of typhoid fever. Here it may be mentioned that Bossi's case, referred to above, may be an example of the manner in which the poison is absorbed through the alimentary canal—not an example of direct implantation. In many of the cases of diphtheria which I have seen during the last few years, the drinking water was found to be contaminated with excrementitious matter.

As regards direct *inoculation with diphtheritic membrane*, the experiments made with false membrane, by Trousseau,³ Peter, and Duchamp,⁴ upon themselves, and by Dr. G. Harley⁵

¹ Sir J. R. Cormack: "Clinical Studies," vol. ii. p. 273; "Lo Sperimentale," 1872, p. 230.

² Dr. Sanderson has placed on record a somewhat analogous illustration: Three sows which had access to a piece of waste ground on which "the discharges or concretions" of some patients suffering from diphtheria were thrown, quickly died with symptoms of suffocation, enlarged submaxillary glands, and in one case with diphtheritic membrane in the fauces.—"Reports of the Medical Officer to the Privy Council." London, 1860.

³ Op. cit. p. 335.

⁴ "Du rôle des parasites dans la diphthérie."—"Thèse de Paris." 1875.

⁵ "Pathological Transactions," vol. x. p. 315.

upon animals, gave only negative results. In the experiments of Trendelenburg¹ and Oertel,² on rabbits, a diphtheritic membrane formed in the trachea, as the result of direct irritation of that part with diphtheritic matter, and the animals died on the second or third day, with acute kidney disease and symptoms of general infection. Nassiloff³ and Eberth⁴ have produced diphtheritic keratitis by direct inoculation, while Hueter and Tommasi⁵ and Oertel, in their experiments on the museles, found that soon after inoculation a diphtheritic layer appeared round the edges of the wound, hæmorrhagic inflammation was induced in the muscles, and the animals died on the second day from general blood-poisoning. Although in some of these experiments a false membrane was produced, the septicæmia may have been merely the result of inoculation with decomposing animal matter, and it cannot be considered that true diphtheria with its specific manifestations has yet been artificially produced by inoculation of the lower animals, though certain local phenomena of great interest and importance have been induced. The remarkable case related by Dr. Paterson⁶ has an important bearing on the question of inoculation with diphtheritic membrane: A man put his finger down the throat of a child suffering from diphtheria. The finger had a wound upon it at the time, which shortly after became ulcerated. All the constitutional symptoms of diphtheria subsequently appeared, and were followed by general paralysis of the extremities.

A few cases are on record in which medical practitioners are said to have been *inoculated with blood*, i.e. to have become infected through the accidental prick of a lancet smeared with the blood of a patient suffering from diphtheria, but as it is extremely difficult to inoculate successfully with blood

¹ "Arch. für Klin. Chirurgie," 1869, x. 2.

² Loc. cit.

³ Virchow's "Archiv." 1870, p. 550.

⁴ "Correspondenzblatt," 1872.

⁵ "Centralblatt f. Med. Wissenschaften," 1868, p. 34.

⁶ "Medical Times and Gazette," 1866.

in other diseases of much higher contagious power, it is very improbable that diphtheria can originate in this way.¹ Moreover, it must not be forgotten that in the cases referred to the medical men attacked were exposed to the general influence of the contagion.

Period of Incubation.—The period of incubation is exceedingly short—generally two or three days; but on the other hand the germs of the disease may remain about the person subsequently attacked for some weeks before the complaint makes its appearance. In illustration of the first-named fact, the following case which came under my own observation may be cited. A girl, aged six, who had been absent from home for five weeks, returned one afternoon at four o'clock. Her young brother, aged four, had shown symptoms of sore-throat the same morning, but no suspicion was entertained that the disease was diphtheritic. These two children remained together till bed time, but did not sleep in the same room. The next morning both of them had marked diphtheria, with an abundance of false membrane. The little girl had not been subjected to any infection before reaching her home. On the other hand, I have known one instance in which the disease occurred fifteen days after exposure to contagion: A young lady, aged eighteen, insisted, contrary to the advice of her friends, in paying a visit to her cousins living in London, who were convalescent from diphtheria. She spent about two hours in their society, and then returned to her home in the country. Fifteen days after her visit she was attacked with diphtheria.

Predisponents.—The most obvious predisposing cause is *age*. From an analysis² of nearly 70,000 fatal cases contained in the returns of the Registrar-General, it appears that in every thousand fatal cases the age at death is as follows:—

¹ Dr. Klein: "Experimental Contribution to the Etiology of Infectious Diseases."—"Quarterly Journal of Microscop. Sc." vol. xviii. p. 169, et seq.

² Thursfield: Loc. cit.

Under 1 year	..	..	..	..	90
From 1 to 5 years	..	..	..	..	450
„ 5 to 10	„	..	..	..	260
„ 10 to 15	„	..	..	..	90
„ 15 to 25	„	..	..	..	50
„ 25 to 45	„	..	..	..	35
„ 45 years and upwards	..	..	..	..	25

Again, in the Florentine epidemic¹, out of 1,546 cases occurring in the years 1872 and 1873, in only fifteen were the patients over thirty years of age. These figures are markedly different from any which could be compiled of other zymotic diseases. It will be seen from the Registrar-General's figures; quoted above, that the disease is comparatively rare in children in their first year, and it was once generally supposed that the infection invariably passed over the recently born. It has been conclusively shown, however, that such is not always the case. Bretonneau,² Dewees,³ and Billard,⁴ have recorded cases in which diphtheria attacked infants at the breast, and M. G. Siredey⁵ has recently collected several similar observations, the disease in one case manifesting itself on the third day after birth. Sex does not influence the incidence of the disease to any appreciable extent; for although, according to the Registrar-General's returns, the mortality of females from diphtheria is rather

¹ Dr. Borgiotti, Capo medico del Ufficio d'Igiene e Beneficenza, in the "Rendiconto amministrativo della Giunta al Consiglio Comunale di Firenze," collected a series of the most valuable statistics on the Florentine epidemic of 1871-73, but unfortunately they are buried in the Municipal Archives. I am indebted to Dr. Wilson, of Florence, for most kindly copying Borgiotti's figures from the source referred to. Dr. Borgiotti's views are, however, given with considerable detail in the "Atti dell'Accademia Medico-fisica Fiorentina." 1871-72-73. Some of the tables, as well as much other valuable information, are contained in the "Istoria Clinica della Difterite osservata nella Città di Firenze e suoi intorno dal 1862 al 1872." Per Carlo Morelli e Leopoldo Nesti. Firenze, 1873.

² "Traité de la Diphtérie," p. 36.

³ "Diseases of Children," p. 425. Philadelphia.

⁴ "Traité des Maladies des Enfants Nouveau-nés," p. 522, &c.

⁵ "Thèse de Paris." 1877, No. 338.

higher than that of males, the reverse applies to "croup," a term under which a very large proportion of the cases of diphtheria are returned. Next in importance to age as a predisposing cause would seem to come *family susceptibility*.¹ The liability of diphtheria to attack the members of certain families is well proved. Sir William Jenner² lays great stress upon family constitution as being "one of the most important elements favouring the development of the disease and determining its progress." He quotes one case in which five members of a family took the disease, two in which four, and eight in which two were affected. In the Florentine epidemic, in four cases diphtheria proved fatal to three members, and in twenty-two cases to two members of the same family. Some remarkable instances of family susceptibility have come under my own notice. In one case a poor woman had three children of her own, and took care of two others in no way related to herself; her own children were attacked by the disease, and one of them died. The other two children—not her own, who were constantly in the same room with the little patients, never suffered from the disease. In another case four families occupied a house near Woodford, in Essex. In all of them there were several children. Two of the families were related, the mothers being sisters. All the children who were related to each other had diphtheria severely, whilst the children of the other two families escaped entirely. During the progress of the disease no attempt at isolation was made, the healthy children frequently entering the rooms of the patients.

Social position has very slight, if any, influence on the distribution of the disease. In its endemic form it is true that it rarely attacks those who live in healthy and well-ventilated

¹ Two very painful examples of intense family susceptibility have been recently reported; in one case eight, and in another case six children in one family were cut off by the disease within a few days. See "Lancet," 1877, vol. i. p. 919, and "Return of the Registrar-General of Ireland for the last quarter of 1876."

² Op. cit. p. 51.

houses, but where it is epidemic, it manifests no respect for social rank or wealthy surroundings. Under these circumstances, as Dr. Greenhow remarks, "station of life and the enjoyment of affluence, or exposure to the privations of poverty seem to have but small influence either in predisposing persons to take, or to suffer severely from, the disease."¹ The statistics of Dr. Borgiotti² tend to show that *during an epidemic* of diphtheria no importance is to be attached to the hygienic condition of a locality as a cause of the malady. In the Florentine epidemic many persons fell victims who lived in lofty, well-ventilated, and, in all respects, salubrious habitations. It must not be forgotten, moreover, that when diphtheria becomes epidemic in a town, an elaborate system of drainage is calculated to convey the poison by means of the sewers, and that water-closets afford a ready means of contaminating cisterns and introducing sewage gas into residences. Hence, the wealthy are sometimes subjected to causes of infection which the poorest may escape.

When an epidemic exists, the accidental occurrence of a catarrh often seems to attract the specific virus to the throat, and children suffering from enlarged tonsils and relaxed throats are especially liable to contract diphtheria.

Certain acute diseases, as well as those of a chronic character accompanied with great debility, predispose to the disease, and when it attacks persons who have been previously suffering from some other affection it is called *secondary diphtheria*. This subject is considered in Chapter XI.

Much still remains to be explained with regard to the etiology of diphtheria. No satisfactory theory has yet been offered as to the reason why in certain years the disease should spring up in epidemic form and resist all our attempts to arrest it, while at other times it arises, perhaps, in some remote hamlet, without any traceable antecedent, and, after flickering for a time, dies away as suddenly as it appeared.

Protective Influence of an Attack of Diphtheria.—As in the

¹ Op. cit. p. 134.

² Loc. cit.

case of typhoid fever and cholera, an attack of the disease probably affords a protection—though a very slight one—against recurrence. In estimating the protective power exercised by an attack of diphtheria, it must not be forgotten that even in diseases, such as small-pox and scarlatina, where previous attacks afford great subsequent immunity, recurrence does sometimes take place, and that there are many well-established cases on record in which these affections have occurred more than once in the same individual. The fact that diphtheria recurs, in some rare instances, does not therefore by any means disprove its protective influence in the majority of cases. That the disease does sometimes recur, I am well aware, for I have myself known three instances in which children have died from the second attack. In two of these, the first attack (occurring a year previously in one case, and seven months in the other) was seen by another practitioner; but, from the circumstances of there having been slight paralysis in each instance, I have no doubt as regards the diagnosis. In my own case, I saw a child aged four with pharyngeal diphtheria in May, 1874, who died of laryngeal diphtheria under my care in July, 1875. I have seen the disease occur, in a mild form, three times in the same individual, at intervals of five months, a year, and two years.

CHAPTER III.

SYMPTOMS.

THE symptoms of diphtheria vary in different cases from those of quite a slight sore throat to those of the most serious and malignant blood-poisoning. Between these two extremes we meet with every gradation of intensity. The presence of "false membrane" in the throat is the characteristic symptom, but sometimes, in slight cases, the disease passes off without the formation of any membranous exudation, and occasionally the patient dies before it is developed. Again, the local affection is, in some cases, accompanied with considerable inflammation, whilst in others there is scarcely a trace of it. Hence it is convenient, in describing the symptoms, to classify the varieties of the disease. The following are the different constitutional forms: (1) *The typical form*; (2) *the mild, or catarrhal form*; (3) *the inflammatory form*; (4) *the malignant form*; (5) *the gangrenous form*; (6) *the chronic form*. An attempt has been made to establish another variety—the insidious form; but whilst one author¹ finds its expression in the sudden development of laryngeal symptoms, another² considers that the patient either dies "from the progress of marasmus," "or suddenly from an effort," or quickly succumbs to one of the unfavourable complications which supervene. It will be seen, therefore, that the insidious character cannot be regarded as constituting a special form of the disease.

The student must not expect to find the first three forms always clearly defined; on the contrary, they are apt to run

¹ Jenner: Loc. cit. p. 20.

² Sanné: Loc. cit. p. 123.

into one another, or their special features may be more or less combined. The differences dependent on site are—(a), *nasal diphtheria*; and (b), *laryngeal diphtheria* or *croup*. It would be foreign to the scope of this work to enter into the subject of cutaneous diphtheria, or to consider the local manifestations of the affection, when it attacks any of the various organs whose mucous covering is susceptible to the poison.

The course of (1) *typical diphtheria* is somewhat as follows: After a period of incubation varying from two to five days, during which the patient suffers from general *malaise* and depression, with occasional chilliness, the disease announces itself by a definite constitutional disturbance.

The *first stage* commences with a rapid rise in the temperature and pulse-rate—the former often reaching 103° and occasionally 104° F. within a few hours—an increased feeling of chilliness, loss of appetite, nausea, and in some instances vomiting or diarrhoea. If the patient is an adult he complains of pain in the loins, of headache, and often of giddiness. His attention is, however, soon diverted from these general symptoms to his throat, which in a very short time begins to feel hot and dry, and to cause pain in swallowing, whilst the neck feels stiff, swollen, and tender. In a child these subjective symptoms are to a great extent lost. The practitioner, called to a case such as is here described, will at once proceed to inspect the patient's throat, and will probably find the tonsils, the pillars of the fauces, the uvula, and the back of the pharynx red, swollen, and turgid. But the false membranes which are characteristic of the disease will very possibly have not yet made their appearance. If they have not, a few hours will probably suffice to develop them.

The *second stage* will then be present. On carefully watching the progress of the case a viscid, yellowish secretion will be seen gradually accumulating in the depressions on one or both tonsils; a little later the superficial layers of mucous membrane become infiltrated at certain points with a yellow

substance, which raises them above the level of the surrounding normal tissue. The infiltrated patches, which are at first more or less translucent, soon become opaque, at the same time changing in colour from yellow to a greyish white, extending at their periphery, and coalescing with similar adjacent patches. In this way a considerable surface of the fauces and pharynx becomes coated with false membrane, which, being constantly reinforced by additions to its under surface, gradually assumes a leathery consistence and a lardaceous appearance. Strips of this membrane may now be torn off, and in some cases with care the whole of it may be removed in the form of a cast of the parts on which it is deposited. The mucous membrane beneath will be found robbed of its epithelium, of a vivid red colour, and covered with numerous hæmorrhagic points. Externally the neck is more or less swollen and brawny, whilst the parotid, sub-maxillary, and lymphatic glands are frequently enlarged, hard, and tender.

The temperature in most cases gradually subsides as the exudation extends, but sometimes it remains at a high point, and may even increase as the local process develops. According to Faralli,¹ however, who made a series of careful observations on the temperature in sixty cases of diphtheria in the Florentine epidemic, it usually falls to normal by the fourth or fifth day, though in moderately severe cases it again shows a tendency to rise after that date.

The patient still complains of difficulty in deglutition, and suffers from a constant "hawking," caused by his endeavours to get rid of the tenacious secretion which is poured out from the mucous membrane. Unless the mouth is repeatedly washed out with a disinfectant gargle the breath becomes horribly offensive, from the decomposition of the morbid secretions in the throat. The *primary* blood-poisoning is shown by the extreme debility, and by the character of the pulse, which is frequently weak and compressible, and often either excep-

¹ "Sul ciclo termico della difterite"—"Imparziale." Marzo, 1873.

tionally rapid or exceptionally slow, while the first sound of the heart is muffled, and devoid of tone; the specific septicæmia is further shown by the albuminuria, which is an almost constant symptom in this class of cases, and appears at a very early period of the disease. The urine itself is scanty and high-coloured, containing an excess of urea, and numerous hyaline, granular, and epithelial casts.

It is at this period that the diphtheritic process, instead of limiting itself to the pharynx, may spread in a downward direction, and attack the larynx and trachea, thus exposing the patient to the serious risk of death from asphyxia. This extension, when it occurs, usually takes place within three or four days of the invasion of the disease, and is in most cases announced by unmistakable signs. The voice becomes hoarse and muffled, the breathing is more or less stridulous, and there is a constant dry and toneless cough. To these symptoms succeed those of embarrassed respiration, viz., distressing dyspnoea, gradually increasing cyanosis, swelling of the face, and drowsiness, passing into fatal coma. We have, in fact, a case of laryngeal diphtheria or true croup—one of the most fatal diseases to which humanity is liable. This important subject will be found treated in detail in Chapter IX.

The other extensions are less important, but are of unfavourable significance. The implication of the nasal cavity generally announces itself by the discharge of a foetid, dark coloured, watery fluid, which excoriates the margins of the nostrils. This condition may remain until the patient recovers or dies, or it may be followed by the formation of false membrane on the lining membrane of the nose, and the discharge of fibrinous lumps through the anterior or posterior nares. It is sometimes accompanied by repeated and perhaps fatal epistaxis. More rarely there is blocking up of the lachrymal duct, and consequent overflow of tears. Cases, indeed, occasionally occur in which the diphtheritic process extends by this route to the conjunctiva,

and a plastic exudation takes place on that membrane. If the inflammation pass along the Eustachian tube, complaint will be made of roaring noises in the ears, of darting pains, and of deafness, which may be followed by perforation of the membrana tympani, and the discharge of a purulent fluid.

Supposing that the disease has not attacked the larynx, the *third stage* now sets in, and the disease pursues one of two courses: it may subside, and the patient may slowly recover; or it may quickly end in death.

If the disease terminates favourably a marked improvement in all the symptoms takes place, as a rule, at the end of the first or at the beginning of the second week. The swelling and injection of the mucous membrane steadily subside, the exudation ceases to extend, and portions are successively loosened and thrown off. All the local discomfort rapidly disappears, and the general symptoms improve. The temperature and pulse-rate fall to normal and remain so, the appetite returns, the urine becomes of natural colour and quality, the skin resumes its functions, and with the exception of a certain degree of muscular weakness the patient feels quite well. He is not, however, as yet quite out of danger; it is not at all an unfrequent event for a relapse to occur, with a fresh formation of false membrane, and a return of all the most serious symptoms; or the heart's action may show signs of failure, and he may die of syncope. Even if he escape these contingencies, he may at a later period experience the discomforts of diphtheritic paralysis.

If the disease, instead of yielding, take an unfavourable turn, the patient may either sink from *secondary* blood-poisoning, with typhoid symptoms, or gradually deepening coma; more often, however, death occurs from cardiac embolism or simple syncope.

(2.) In *mild or catarrhal diphtheria* the symptoms are often so slight that the practitioner hesitates to attribute them to a disease, the very name of which is heard with consternation. Indeed it is, as a rule, only when

his attention is aroused by the proximity of other undoubted cases, that he is at all likely to recognize the affection in its earlier stages. The symptoms are simply those of an ordinary catarrhal sore-throat. The diphtheria, in fact, has been arrested at the first stage of its development. The constitutional disturbance is very slight; the temperature rises a degree or two above the normal, and the pulse is quickened in proportion. There is slight pain, and a feeling of dryness in the throat, and as a rule some degree of difficulty in swallowing. The submaxillary and cervical glands are not unfrequently swollen and tender. On inspecting the patient's fauces, no characteristic exudation is seen. The tonsils, soft palate, and back of the pharynx are of a bright-red colour, and somewhat swollen. In many cases the redness and swelling are limited to one side of the throat, the opposite side presenting an appearance of perfect health. At first the throat is dry, and there is a marked diminution in the quantity of the natural secretion; but this stage soon passes, and then minute accumulations of yellowish matter, not much exceeding the size of a pin's head, may be seen adhering to the surface of the tonsils, or to the posterior wall of the pharynx. These may be readily removed with a camel's-hair brush. As a rule the patients quickly recover, and by the third or fourth day may be declared convalescent. They often, however, suffer from a considerable degree of prostration during the illness, and a sense of weakness may remain for some days or weeks after the disappearance of the local affection. The symptoms above sketched are sometimes associated with a trace of albumen in the urine, but occasionally the first evidence of the true nature of the throat affection is the occurrence of the characteristic paralysis. The appearance of one or other of these symptoms often forms the only clue which the physician has to the nature of the primary affection, which in all other respects closely resembled a simple sore-throat. In some instances, however, the catarrhal affection serves only to introduce the more serious form of the disease. In such cases,

after the more trivial symptoms have lasted for three or four days, there is a sudden accession of fever, with marked constitutional disturbance and increase in the local symptoms. Exudation forms rapidly in the throat, and with it the disease assumes all the characters which have already been described under "typical diphtheria."

(3.) The *inflammatory form of diphtheria* is characterized by the active hyperæmia which precedes, and accompanies, the exudation of lymph. On examining the throat, the appearance is that of acute pharyngitis, the mucous membrane of the uvula and fauces being greatly inflamed. Within twenty-four hours a thick false membrane usually covers the inflamed parts, but I have met with one case in which the exudation did not take place till four days after severe inflammation commenced. The tonsils are often increased in size, and the glands at the angle of the jaw are generally enlarged and tender. There is severe odynphagia. The pulse is very frequent, and the patient has a hot, dry skin, and often complains of great thirst. It is in this form of diphtheria, as Sir William Jenner¹ has pointed out, that the joints sometimes become swollen and inflamed.

(4.) In *malignant diphtheria* the attack begins with severe rigors, headache, and vomiting, and there is often also bleeding of the nose. The patient is at once, as it were, knocked down by the virulence of the disease. The throat-symptoms are not generally severe, but the secretions rapidly undergo decomposition, and cause the breath to have a most intolerable fœtor. The temperature is not high, but the pulse is rapid, small, and irregular. Restless at first, the patient soon becomes apathetic and drowsy; his face grows pale, and his skin cold and clammy. The tongue is brown, dry, and tremulous, and sordes form upon the teeth. Hæmorrhages may occur from the various mucous surfaces, and petechiæ often appear beneath the skin. In short, all the symptoms of the

¹ Loc. cit. pp. 17, 18.

typhoid state are present, and the patient finally becomes delirious and dies comatose, or succumbs to an attack of syncope.

(5.) *Gangrenous diphtheria* is very rare in this country, except as a secondary phenomenon following scarlet fever. The gangrene frequently supervenes with great rapidity after the formation of the false membrane, so that in two or three days a large portion of the pharyngeal mucous membrane may be sphacelated. In some cases there is considerable swelling of the cervical glands, but this lesion is not invariably present. As the morbid process becomes fully developed, it is in all instances accompanied by a remarkable prostration of the vital powers. A state of collapse comparable to that which occurs in cholera indicates the intensity of the blood-poisoning; there is great loss of body-heat, and the pulse soon becomes slow and infrequent. The extremely feeble condition of the circulation is shown by the pallor, coldness, and bluish discoloration of the skin, especially of the extremities. The expression of the face is strikingly altered and pinched. The patient generally dies from syncope, the intelligence often remaining intact to the last. In some cases, however, he becomes comatose, and occasionally symptoms indicative of profound lesions of the thoracic or abdominal viscera are manifested. These cases always terminate fatally.

(6.) *Chronic diphtheria* is a rare disease. In the years 1863 and 1864 eleven patients (seven men and four women) came under my care in whose cases there was false membrane in the pharynx. In three of them at the same time there was deposit in the larynx. The patients were all able to attend as out-patients at the hospital, and though in several cases they were weak, yet they showed no very great degree of debility. In four instances there was albuminuria: in two of these it was intermittent and in two constant. The longest duration of any of these cases was three months, the shortest seven weeks, the average being nine weeks. In all

the cases, when the false membrane was mechanically removed, bleeding occurred, and a fresh formation quickly took place. Various local treatment was adopted, but without any decided success. The power of maintaining the false membrane seemed to be lost after a time, and the lymph was at last separated without reproduction. Barthez¹ has also described a case where the false membrane lasted for several weeks, and showed a highly persistent power of reproduction, and Isambert² mentions an instance in which a student became affected with nasal diphtheria, and continued for several months to expel pieces of false membrane on blowing his nose. More recently M. Hybre³ has published two cases, observed in the Hôpital Sainte-Eugénie in which false membranes were expelled for eight and ten weeks respectively after the performance of tracheotomy for laryngeal diphtheria. The patients were young children, they recovered rapidly from the operation, and appeared quite well, except for occasional attacks of suffocation, generally followed at an interval by the expulsion of pieces of false membrane from the wound in the throat. In neither case was there any albumen in the urine, or any extension of the disease to the bronchi. The false membranes expelled presented all the microscopic characters of diphtheritic exudation. Both children completely recovered. M. Hybre has described these cases as examples of chronic non-febrile diphtheria, but he has also collected several cases in which the disease, though running a chronic course, was associated with more or less febrile disturbance.

Some of the symptoms of diphtheria demand a more detailed discussion than has been accorded them above.

The occurrence of *albuminuria* in cases of diphtheria was discovered by Dr. W. F. Wade,⁴ of Birmingham, in the

¹ "Bull. de la Soc. Méd. des. Hôp." 1858.

² Lorain et Lépine: "Nouveau Dict." 1869.

³ "Thèse de Paris." 1875, No. 462.

⁴ "Midland Quarterly Journal of the Medical Sciences," April, 1858.

year 1857, and some months later it was independently observed by Dr. Germain Sée, of Paris.¹ In the greater number of cases of diphtheria the urine is found to be albuminous at some period of the disease. The albumen usually makes its appearance within the first few days, and sometimes within the first twenty-four hours of the invasion,² but it may be delayed until as late as the third week. Its presence is rarely constant in any case. It may fluctuate considerably in quantity from day to day and from hour to hour, and it may disappear and reappear more than once before recovery sets in. The severity of the case furnishes us with no indication as to the probable occurrence of albuminuria; it has been searched for in vain in some most malignant cases, and it has been detected in the course of very mild attacks. It is never associated with any tangible amount of hæmaturia, but the urinary deposit usually contains hyaline, granular, and epithelial casts of the renal tubules. The urine itself is generally more or less highly coloured, and of high specific gravity, and it contains a considerable excess of urea, as is the case in most other diseases of a pyrexial character. The albuminuria of diphtheria is almost always a transient phenomenon, and it is quite exceptional for it to persist after recovery. It seldom results in anasarca, and only very rarely in uræmia. It is true that, according to M. Moizard,³ Bergeron has in several cases observed attacks of eclampsia supervening on diphtheritic albuminuria in children, and the former writer has recorded a fatal case of pulmonary œdema occurring under similar circumstances; but the general tendency of the evidence is to show that the albuminuria of diphtheria is by no means a dangerous symptom, and recent observations

¹ "Union Médicale." 1858, p. 407.

² Dr. Burdon Sanderson quotes a case in which it appeared eighteen hours after the patient had been apparently in perfect health.

"Contributions to the Pathology of Diphtheritic Sore Throat," &c.

"Brit. and For. Med.-Chir. Rev." January, 1860,

³ Moizard: "Thèse de Paris." 1876, No. 493.

have fully confirmed the dictum of Trousseau,¹ that it has only a limited signification in relation to prognosis and treatment.

The exudation of *false membrane* is an almost invariable phenomenon of diphtheria. There are only two classes of cases in which it may be absent, viz., those in which death from blood-poisoning occurs before the exudation has time to form, and those in which the local process is not severe enough to result in the formation of a definite membrane. This class has been described by Dr. Michel Peter² as "*Diphtherite sine diphtheria.*" False membranes may form in the course of the disease upon any part of the mucous surfaces which are exposed to the air. As a rule, they attach themselves by preference to the more prominent parts. They may extend from the pharynx to the epiglottis and ary-epiglottic folds, and from thence by the ventricular bands and vocal cords, into the trachea, and may only be arrested in the smaller bronchi. They may spread upwards into the nasal passages, covering the whole cavity and following the windings of the turbinated bones. They may appear at the orifices of the nares and attack the excoriated skin around them : they may extend up the lachrymal duct and show themselves upon the conjunctiva. In some rare cases they have been known to invade the œsophagus, and they occasionally cover the tongue and the mucous membrane of the lips. In women who are suckling infants the disease sometimes appears on the nipple. In both sexes it may attack the mucous membrane near the orifice of any of the internal passages. External wounds of every sort are liable to be covered by false membrane. In short, no part of the body which is at once open to the air and uncovered by a thick epidermis, is free from the liability of local infection and the consequent formation of false membrane. The exudation may take place within a few hours of the invasion

¹ Trousseau : Op. cit. vol. ii. p. 538.

² "Thèse de Paris." Paris, 1859, No. 270.

of the disease, or may be delayed for four or five days. The first sign of it consists in the infiltration of the superficial layers of mucous membrane with a yellowish substance, which raises the affected parts above the level of the surrounding surface. The further changes which take place have been already described. When the first membrane has been removed artificially, fibrinous exudation may again form, or the surface may gradually heal. When, however, the membrane has become detached of its own accord, recurrence in the same spot is rare.

The symptoms of *fever* in diphtheria may either be very marked or almost absent. In the severest and most malignant cases the temperature is often quite low. There is never any tendency to extreme hyperpyrexia. In the usual run of cases it would appear that the variations of temperature follow a fairly definite course. Trousseau states that there is a rather acute development of fever at the time of the attack, but that the feverish symptoms diminish on the second day, and cease on the following or next day. Wunderlich considers that the temperature in diphtheria is of little prognostic value,¹ but Faralli, to whom I have already referred, has shown that there is a definite pyrexial cycle in cases of diphtheria, which furnishes data both for diagnosis and prognosis. The observations which he has made prove that fever is a phenomenon commonly present in diphtheria. The elevation of temperature is rapid, and even in slight cases it frequently rises as high as 104° in a few hours, falling gradually until the normal point is reached on the fourth or fifth day. In cases of moderate severity the temperature again rises towards the fourth day, but seldom regains the height of the first elevation. The exacerbation is due to the appearance of fresh diphtheritic patches on parts previously healthy, or, more frequently, to the appearance of glandular enlargements, the result of secondary infection.

¹ "Temperature in Diseases" (New Sydenham Society's Translation), p. 367.

The effects of this secondary infection are clearly observed in severe cases which pass into the typhoid state. In these the temperature at first follows the same course as in the milder cases ; that is, it rises rapidly and falls steadily until the third or fourth day. At that date it rises again, with some irregularity, but with a certain relation to the extension of the local disease, and to the putrefactive changes in the membranes. In favourable cases a second steady fall succeeds the second elevation, while in fatal cases the temperature continues to rise until the last. The natural course of the temperature may at any time be modified by the supervention of impeded respiration, which will have the effect of reducing it. Dr. Faralli's observations were not simply confined to pharyngo-laryngeal diphtheria. In a case in which diphtheria affected a wound, he obtained the same results. The temperature rose within a few hours to over 105° , before the false membrane was clearly developed. It fell to normal on the third day, while the infiltration was at its maximum.

Similar results to those obtained by Faralli were arrived at independently at about the same time by M. Labadie-Lagrave,¹ who made careful thermometric observations in fifty-five cases of the disease. From a comparative study of these cases he deduced the following general rules:—(1) The temperature generally rises to 104° on the first day, and remains at about that point for two or three days, without any marked morning or evening remissions. (2) It begins to fall on the third or fourth day of the disease, and then invariably continues to fluctuate between 99.5° and 101.5° , unless some complication develops. (3) Tracheotomy exerts no marked influence on the temperature. (4) In favourable cases, after the initial pyrexia has subsided, the temperature never rises above 102° . A sudden ascent to 103° or 104° on the fifth or sixth day of the disease points to the development of some complication, either lobular pneumonia, acute nephritis, or acute endocarditis. M. Labadie-Lagrave attaches

¹ "Thèse de Paris." 1873, No. 117.

considerable importance to the last-named complication and its results; his views on this subject will be treated in greater detail under Pathology.

Cutaneous eruptions are not uncommon in some epidemics of diphtheria, especially among children. Their most common situations are the neck and chest; occasionally they make their appearance on the face, abdomen, and thighs. A rash is most frequently met with in the severest cases. The date of its appearance is not definite, and its duration is very variable. Sometimes it disappears in a few hours, in other cases it persists for several days. The rash of diphtheria generally more or less resembles the rash of scarlet fever, and consists of minute red isolated spots, which disappear on pressure. It differs from that of scarlet fever in the fact that it is never followed by desquamation.

CHAPTER IV.

PARALYSES.

SETTING aside extreme debility and a disposition to cardiac syncope, which may be considered rather as characteristics of the disease itself, the only serious sequelæ of diphtheria are various local paralyses. As has already been pointed out, the occurrence of paralyses was noticed by Cœlius Aurelianus, Severino, Ghisi, and Chomel. We might add the names of several other physicians who in the seventeenth and eighteenth centuries incidentally referred to the subject. It is sufficient, however, to remark that the first important work on diphtherial paralyses was the thesis of M. Maingault,¹ published in 1864. These paralyses are liable to follow any case, however slight. M. Mansord² has collected from various sources 1,117 cases of diphtheria, in which the presence or absence of subsequent paralyses was noted. They were found in 111 cases, or barely 10 per cent. Probably, however, the proportion varies considerably in different epidemics. The character of the paralyses is also very varied. They may be partial or complete, and they may either limit themselves to single groups of muscles, or may involve in succession almost the whole voluntary muscular system. Their advent is always gradual, and as a rule they declare themselves during the second or third week after the complete healing of the local lesion. Trousseau,³ however, quotes a case in which

¹ Paris, 1864.

² Mansord: "Thèse de Paris." 1874, No. 52.

³ "Gazette des Hôpitaux." 1860, Nos. 1 and 5.

they became manifest three days before the disappearance of the false membrane. On the other hand, they may be delayed until as late as the sixth week of convalescence. In any case their advance is gradual, and they may continue to extend for weeks after their first appearance. The muscles most frequently affected are those of the soft palate and pharynx, of the eye, and of the extremities. It is much more rare for the muscles of the larynx and trunk to be implicated, while those of the bladder and rectum are still more seldom affected, and those of the face, almost always, though not invariably, escape. Concurrently with the paralysis, there is impairment of muscular, and sometimes of cutaneous, sensibility. The muscles generally respond languidly to both galvanism and faradism, while the patient complains of numbness and prickings in the paralyzed parts. More rarely there is pain or hyperæsthesia. The affected muscles occasionally undergo a slight degree of wasting, and in some cases their diminution in bulk is very considerable.

The first muscles to be affected are usually those of the soft palate and pharynx. The nerve cells of the ganglia supplying the pharynx would appear to have a special predisposition to give way, for even in cases of cutaneous diphtheria the palate is the first part to be paralyzed.¹

On inspection, the *velum pendulum palati* and uvula are seen to be relaxed, and although during inspiration and expiration the uvula moves backwards and forwards under the force of the current of air, the power of voluntary raising it, is, to a great extent, lost. This feature is generally unilateral, and when bilateral it always affects one side much less than the other, giving rise to a mere paresis of the muscles on the side least affected. There is also generally loss of sensibility in the veil of the palate.

The voice acquires a characteristic nasal timbre, the modi-

¹ Morelli (Loc. cit. p. 122) thinks that there is a frequent, but not invariable, coincidence between the paralytic manifestations and the cervical adenitis.

fication of certain articulate sounds being very characteristic, owing to the impossibility of closing the naso-pharyngeal passage. Thus: *rub*, *head*, and *egg* become *rum*, *hent*, and *enk*.¹

The pharyngeal affection often gives rise to dysphagia. The patient first perceives the difficulty of swallowing, in taking fluids, which frequently regurgitate through the nose or pass into the larynx, and occasionally life can only be sustained by the use of the œsophageal feeding tube. The dysphagia, as will presently be explained, is partly due to the implication of the depressors of the epiglottis. The power of expectoration is often lost, and mucus accumulates about the lower part of the pharynx, and is only dislodged by an effort of vomiting. In some cases a constant pricking sensation is felt in the throat. The taste is always more or less blunted.

Paralysis of the larynx is much less common than the palsies already described, but in rare cases it may appear even without other parts being affected. The paralysis may involve the whole muscular apparatus of the larynx, or may limit itself to single muscles. In the former case the vocal cords will be seen, on laryngoscopic examination, to remain motionless during phonation, occupying the post-mortem position. The voice is almost entirely lost, and any increased exertion leads to considerable dyspnoea, not from paralysis of the abductors, but from loss of power of the adductors, and consequent inability "to hold the breath"—an act which is especially necessary for delicate persons when making an effort. When the paralysis only involves single muscles, it is the adductors which generally suffer, but often only one cord is affected. Two cases of permanent paralysis of the recurrent nerve, following diphtheria, have come under my notice. The muscular paralysis of the epiglottis is occasionally associated with loss of sensibility of its mucous membrane, in which case portions of food are more likely to make their

¹ Donders: "New Sydenham Soc. Trans." 1864.

way into the larynx than when the pharynx alone is affected. Such an accident may give rise to very serious symptoms.

The muscles of the eye are the next to suffer. Indeed, in some cases, they become paralyzed at the same time as the muscles of the palate. The patient first notices that it is getting more and more difficult for him to read small print. The effort tires him, and causes pain in his eyes; soon his vision becomes quite indistinct, and he suffers from flashes of light before the eyes. He does not, however, lose the power of seeing distant objects. At a later period there may be double vision, giddiness, and squinting, from palsy of the oculo-motor muscles. The earlier symptoms are due, according to Donders,² to impairment of accommodation—from palsy of the ciliary muscles. The chief affection of the sense of sight, therefore, depends on paralysis of parts supplied by the lenticular ganglion of the sympathetic chain, as the pharyngeal paralysis appears to be due to impairment of Meckel's ganglion, and these facts have led Dr. Hughlings Jackson¹ to inquire, in cases of diphtheritic paralysis, for a corresponding affection of the sense of hearing, such as would be likely to result from interference with the function of the otic ganglion. He has hitherto only met with one such case, that of a medical man. The affection was not sufficient to impair his hearing for ordinary purposes, but "enough to render music unintelligible." In fact, as Dr. Jackson says, we should not expect deafness as the result of diphtheritic paralysis, but only slight interference with the power of appreciating high-pitched sounds. It is impossible to tell as yet how frequent such an affection may be in cases of diphtheritic paralysis. As far as our knowledge at present goes, it is little more than a pathological curiosity.

Next in order to the muscles of the eye, those of the

¹ *Op. cit.*

² "Ophthalmology in its relation to General Medicine,"—"British Medical Journal," May 12, 1877, p. 505.

extremities most frequently show signs of paralysis. The lower extremities are usually the first to be affected. The patient first suffers from numbness and tingling in the feet. Soon, on attempting to walk, his legs begin to tremble, and he feels as though he were walking on air. In very severe cases the difficulty gradually increases, his movements grow more and more clumsy, until at length he loses all power over his legs, and becomes a helpless cripple. Dr. Hermann Weber,¹ has especially called attention to the want of power of muscular co-ordination, as shown by the choreic movements. The muscles of the affected parts feel flabby to the touch, and they refuse to respond to the electric current. Cutaneous sensibility is also much impaired, or entirely abolished, especially in the soles of the feet. The same symptoms may occur in the upper extremities. There is, first, numbness and formication in the fingers, then increasing clumsiness of movement, and finally, complete paralysis.

The last muscles to be affected are generally those of the neck and trunk. Paralysis of the former in its worst forms deprives the patient of the power of raising or turning his head, which falls helplessly backwards and forwards, or drops to one side. Paralysis of the trunk renders turning or moving in bed impossible, and at the same time causes considerable embarrassment to respiration from the implication of the intercostals. When the diaphragm is also paralyzed, as in rare cases it is, the difficulty of breathing is enormously increased, and the patient runs the greatest risk of dying from asphyxia. If, however, the paralysis be not complete, the danger may be warded off, and the patient may gradually recover. Concurrently with the paralysis of the extremities in the most severe cases, there is often incontinence of urine and feces from palsy of the sphincters of the bladder and rectum.

Having continued for a period varying from six weeks to

¹ Loc. cit.

half-a-year these paralyses, as a rule, gradually disappear in the order in which they appeared, the duration being in each case proportionate to the degree of paralysis. Suitable treatment no doubt expedites recovery, but, in these cases, there is a natural tendency to the restoration of function. If no unfortunate complications lead to a fatal result, eventual recovery of muscular power may almost invariably be counted upon; but in most cases the patient continues for a long time to experience some degree of weakness in the affected parts. Lastly, it is well to remember that the severity of the paralytic symptoms bears no proportion whatever to the severity of the antecedent disease. The loss of power may occur in a marked degree after even the most trivial attacks.

CHAPTER V.

DIAGNOSIS.

IN some cases of diphtheria an absolute diagnosis may be almost a matter of impossibility, at any rate in the earlier stages of the disease. The difficulty generally arises in those cases which deviate from the normal type in the direction either of unusual mildness or of unusual severity. Very mild cases, in which the false membrane is either absent or late in appearing, may easily be confounded with ordinary catarrhal sore throat. The diagnostic criteria are both few and indefinite. A history of infection, or the epidemic prevalence of diphtheria, may in some cases be of service in forming an opinion, but more often the practitioner has to trust to other data. In the case of the diphtheritic sore throat, without false membrane, the congestion is at once more limited and more intense than in pharyngeal catarrh; it often affects one lateral half of the soft palate, or one tonsil, while the catarrhal process has usually a more general distribution. In simple sore throat the surface of the tonsils may be covered here and there with patches of deposit, which might possibly mislead an ignorant or incautious observer; but such deposits will invariably be found to be soft, semi-fluid, and easily removed. They are, in fact, nothing more than the modified secretion of the congested mucous structures. In diphtheria, moreover, there is often albuminuria, and a degree of prostration out of proportion to the severity of the local changes. In many cases, in the absence of false membrane, the practitioner must rest content with a diagnosis founded upon unsatisfactory

criteria. In other cases, however, the sudden development of exudation and the appearance of serious symptoms of general infection may clear up all doubt; while in still rarer instances the supervention of muscular paralysis during convalescence will solve the problem in a quite unexpected manner. It is hardly necessary to add that, in all cases of suspected diphtheria, it is the bounden duty of the practitioner to make a most thorough examination of the interior of the throat, supplementing it, if possible, by the use of the laryngoscope and rhinoscope. These instruments will often bring to light patches of exudation, and will thus give very material help towards a satisfactory diagnosis.

The cases in which diphtheria appears in an exceptionally severe form may offer still greater difficulties in the way of diagnosis than even mild cases. A patient, for instance, is suddenly struck down by intense general blood-poisoning, and rapidly passes into what is named the typhoid state. If inspection of the fauces is neglected in such a case, the physician may experience the greatest perplexity as to the nature of the disease. Even the fauces may appear healthy, and the case be still one of diphtheria; for the membrane may not as yet have had time to form, or may have formed beyond the range of sight. The only aid to diagnosis in such a case will be found in the character of the prevailing epidemic. Malignant diphtheria very rarely occurs in an endemic form.

Apart from the above difficulties, diphtheria may simulate, and be simulated by, scarlet fever, confluent herpes of the throat, acute tonsillitis, and acute laryngitis. There can be no doubt that, in many cases, diphtheria has been mistaken for scarlet fever. The severe constitutional disturbance, the sore throat, and the rash, which is a common symptom in some epidemics of diphtheria, are all liable to mislead the observer. But the points of difference are fairly well marked. The constitutional symptoms are usually slighter

in diphtheria ; there is, as a rule, less anorexia, but more prostration. The throat in scarlet fever is uniformly reddened, and if it be the seat of any membraniform deposits, these are soft and easily detached. The larynx, moreover, is only very exceptionally attacked. There may be albuminuria in either disease, but hæmaturia, which is scarcely ever known to occur in diphtheria, is not uncommon in scarlet fever. The distinctive characters of the rashes have already been described.

Acute tonsillitis at its outset may simulate the inflammatory form of diphtheria. In both there is considerable constitutional disturbance and difficulty of swallowing ; in both the throat affection has a more or less unilateral tendency, and commences with intense congestion. In tonsillitis, however, the inflammation either subsides, or rapidly passes into suppuration, and thus removes all cause of difficulty.

Confluent herpes of the throat is not a common disorder, and is not, therefore, often likely to give rise to difficulties in practice. Trousseau,¹ however, has laid down the diagnostic distinctions between the two diseases with considerable detail. Herpes is usually ushered in with considerable constitutional disturbance, but the temperature rarely rises higher than 102° or 102·5° Fahr., and it quickly subsides. The pain in the throat is of a peculiar smarting character. Herpes has no tendency to spread beyond the seat of its first efflorescence. Thus, if in a doubtful case the morbid process is found extending to the tonsils, to the larynx, or to the nose, herpes may be excluded. Of course the simultaneous appearance of herpes on the lip will be of great help in forming a diagnosis.

The diagnostic distinctions between laryngeal diphtheria and catarrhal laryngitis will be found under the head of "Croup."

¹ Op. cit. vol. ii. p. 439.

CHAPTER VI.

PATHOLOGY.

THE characteristic product of diphtheritic inflammation—the false membrane—is a tough dry substance resembling fibrin, or the buffy-coat of the blood. In colour it is yellowish, or greyish-white; it is firm and elastic, but it breaks across suddenly when stretched. The addition of acetic acid causes it to swell up and become transparent; it is dissolved by caustic alkalies. It is insoluble in water, and yields to it neither gelatine nor albumen. It thus closely resembles fibrin in most of its qualities. The membrane may vary from a thin and transparent pellicle to a skin of considerable thickness, its character differing very much according to its age. In the earlier stages the different patches of membrane are more or less isolated, they are surrounded by mucous membrane in a state of intense hyperæmia, they project only very slightly above the mucous surface, and they cannot be removed without considerable force. Later on the patches are found to have coalesced, they have become firmer and thicker, and evidently project higher above the surrounding surface. In the next stage these edges become loosened, and show a tendency to curl up, giving the exudation a more or less cupped appearance. Pus gradually accumulates beneath it, until it detaches itself, leaving the subjacent mucous membrane in a state of catarrh.

According to the most recent researches, the exudation in *pharyngeal diphtheria* is seen under the microscope to consist exclusively of cells. The naked-eye resemblance to coagu-

lated fibrin is due to a peculiar degeneration of the epithelial cells, and to an equally peculiar fusion of them one with another. The cells manifestly contain more solid matter than normally, but the precise character of the infiltration is as yet uncertain. On examining a section of membrane under the microscope, it is seen to consist of thin changed cells, fused together in various directions, and leaving a system of branching fissures, which permeate the whole membrane. The most superficial cells are twice as large as lymph corpuscles. They gradually decrease in size as we proceed deeper, until those which are in immediate contact with the mucous surface are almost indistinguishable from normal cells. Here and there, scattered throughout the membrane, are often seen minute extravasations of blood, which, originally formed on the mucous surface, have become separated from it and encapsuled by successive layers of degenerated cells. To sum up in the words of Rindfleisch,¹ "the false membrane is undeniably produced by the separation of young elements from the irritated mucous surface and by their gradual stiffening, sclerosis, glassy swelling, or whatever term we may choose to apply to their degeneration." In course of time the mischievous process comes to a standstill. The cells secreted by the mucous membrane no longer undergo the abnormal degeneration; pus cells appear in increasing quantities between the mucous surface and the false membrane, and soon lead to the final separation of the latter. The exudation also disappears to some extent by undergoing a process of softening, the cells becoming granular and fatty, and the network undergoing gelatinous degeneration. This, though not an uncommon termination in favourable cases of tracheal diphtheria, is much rarer when the false membrane is formed in the pharynx.

In describing the symptoms of diphtheria, it has been

¹ "Lehrbuch der Pathol. Gewebelehre," II. Auflage, p. 310. Leipzig, 1871.

pointed out that in the earliest stages of the disease the mucous membrane is inflamed and swollen, but is soon coated with false membrane, and becomes hidden from view. If the disease progresses favourably and the case is not very severe, on separation of the lymph, the mucous membrane is seen to be smooth, and often somewhat paler, than in a state of health; but, if the affection has been at all violent, more or less ulceration of the mucous membrane will be present. Occasionally the morbid process does not stop at ulceration, but gangrene results, and there is considerable loss of tissue. In many fatal cases the gangrenous process is in active operation, and its peculiar odour becomes evident on the post-mortem table, if not during life. The idea, entertained by the ancient physicians, that the disease was of a gangrenous nature was, it need scarcely be observed, derived from the appearance of the false membranes themselves, which, whether white or subsequently discoloured, have very much the aspect of an eschar or slough. This is, of course, only a delusive appearance, and our modern knowledge of the gangrenous process in diphtheria is based on the post-mortem examination of the tissues *beneath* the false membrane. In the severer forms of the disease there is, in addition to the changes above described, an exudation of fibrin into the sub-epithelial connective tissue. The exudation and infiltration sometimes compress the nutrient vessels of the part, and thus arrest its blood supply. Necrosis of the involved tissues results, and leads to the formation of a slough, which is, in course of time, separated from the healthy parts. On the slough becoming finally detached, there is left an ulcer of variable depth and extent. In several cases I have known the patient recover with the loss of the uvula, and with a portion of one or both tonsils destroyed. It is more common, however, in cases of recovery after gangrene to find large and puckered cicatrices resembling those which are seen as the result of syphilitic ulceration.

In addition to the inflammatory products of diphtheria,

there are certain parasitic phenomena. The idea that diphtheria is of parasitic origin was first put forward by Professor Laycock¹ and subsequently revived by Jodin.² More recently Oertel³ has maintained the parasitic theory with great vigour, and has been followed by many German observers. Oertel contends that certain definite forms of vegetable life, especially the spherical bacteria, called *micrococci*, and the smallest forms of *bacterium termo*, are invariably associated with the diphtheritic process. The greyish-white hoarfrost-like patches, which appear on the mucous membrane at the very commencement of the disease, contain, he says, luxuriant growths of micrococci. They are always present in diphtheritic membranes, and they are also found in varying quantity in the blood, whenever such membrane exists. The quantity of them present in any case, moreover, bears, it is affirmed, a direct relation to the intensity of the morbid processes; they multiply as the disease advances, and diminish with its retreat. Oertel states that the special form of micrococcus is never present in simple inflammation of the fauces or in mercurial stomatitis; but that, if the diphtheritic process supervenes on these disorders, it at once makes its appearance, and quickly displaces the more common forms of bacteria previously present. According to Oertel and some other experimentalists (*see* Etiology) after the inoculation of the different tissues of animals with diphtheritic exudation, it has been found that the micrococci force their way amongst the cellular elements, crowd into the blood and lymph vessels, which they render impermeable, infiltrate the muscles, and lead to their degeneration, and even reach the kidney, where they excite the inflammation which is so common a complication of diphtheria. Eberth⁴ has gone so far as to declare that *without micrococci there*

¹ "Medical Times and Gazette," May 29, 1858.

² "De la nature et du traitement du croup, etc."—"Revue Méd." t. i. pp. 22 and 134, Paris, 1859.

³ Ziemssen's "Cyclopædia of Medicine," vol. i. p. 589.

⁴ "Zur Kenntn. der bacterit. Mykosen," 1872.

can be no diphtheria; while, in Italy, Giacchi¹ thinks that a parasite is as necessary in the pathogenesis of the affection, as the *oidium vitis* is in the production of disease of the grape. Letzerich² has found another fungus—the *zygodesmus fuscus*—which he believes is the essential cause of the disease. The conclusions of Oertel and Letzerich have, however, been directly controverted by Senator,³ who has found the *leptothrix buccalis* in diphtheria, and who considers the minute round bodies described by Oertel (as the spherical bacteria) to be the spores of the leptothrix. According to Senator the same fungi are found in diphtheria as in ulcerative, aphthous, and mercurial, stomatitis. And M. Duchamp⁴ states that the growths he found in numerous cases of diphtheria were declared by M. Chauveau to present no difference from those observed in variola, vaccinia, &c. In February, 1874, I examined seven cases for epiphytes, and succeeded in finding what is commonly described as “the leptothrix buccalis” in five instances. In every case, however, the fungus was in the superficial layer of the lymph. The importance of the presence of fungi in diphtheritic deposits is controverted by Dr. Beale,⁵ whose authority, as a microscopist, must carry great weight in this country. This observer maintains that “vegetable germs are present in every part of the body of man and the higher animals, probably from the earliest age, and in all stages of health. . . . Millions of vegetable germs are always present on the dorsum of the tongue and in the alimentary canal.” Dr. Beale further states⁶ that “active bacteria introduced amongst the living matter of healthy tissues will die, although the most minute germs present which escape death may remain em-

¹ “Natura e Terapia dell’angina differica.”—“Lo Sperimentale,” Nov. 1872.

² Virchow’s “Archiv.” Bd. xlv. et seq.

³ “Archiv. für Pathol. Anatomie u. Physiol.” Bd. lvi. No. 12, 1872.

⁴ Duchamp: “Thèse de Paris.” 1875, No. 339.

⁵ “Disease Germs.” London, 1872, p. 65, et seq.

⁶ Ibid. p. 71.

bedded in the tissue in a perfectly quiescent state." He thinks also "that there are very few morbid conditions that are unquestionably solely due to the growth and multiplication of vegetable fungi."¹

The changes which may take place in other tissues in the course of an attack of diphtheria are very various.

The *parotid* and *sub-maxillary glands* which Dr. Samuel Bard² first pointed out as being frequently swollen, have been recently shown by Doctors Balzer and Talamon³ to be the subject of distinct pathological changes. The cells of the acini are generally either swollen and filled with a homogeneous mucoid material, or replaced by quantities of small round cells. Here and there are also frequently minute collections of pus. The *lymphatic glands* of the neck are almost invariably found to be more or less enlarged. On section they are redder than natural, and there is an evident increase in their cellular elements. The tissues around them, which during life were brawny and tender, are found at the autopsy to be infiltrated with serum and with scattered pus-cells. Often they present minute extravasations, while, in rare cases, considerable masses of blood have been found effused in the cellular tissue surrounding the glands.

The *lungs* may be the seat of very varied changes. The bronchial tubes are always inflamed—the inflammation generally being catarrhal, but sometimes purulent; in many cases, however, it is plastic, and then it most commonly occurs on the fourth or fifth day of the disease. On laying open the bronchi, the false membrane is found attached to their walls, or lying loose in their channels. The membrane is never equally extended throughout the whole system of tubes, but seems to have a preference for those branches which run in a vertical direction. The fact of

¹ Ibid. p. 78.

² Loc. cit.

³ "Revue Mensuelle." Le 10 Juillet, 1878.

one of the lungs being bound down by pleuritic adhesion would seem especially to attract the morbid process in that direction. Exudation is not unfrequently found to extend to the minutest bronchial ramifications, in which case the alveoli are usually more or less implicated, and contain fibrinous threads, pus-cells, and, in some cases, blood corpuscles. As a rule, the lungs are more or less engorged and cedematous, especially at their bases; and frequently there are extensive patches of pneumonia of a low type, with emphysema, or more often mere insufflation of the air cells¹ in the immediate vicinity. In other cases scattered lobules are found collapsed and void of air from occlusion of the smaller bronchi, or one of the lobes is the seat of more or less extensive pulmonary apoplexy. According to Peter,² 59·50 per cent. of the cases of broncho-pneumonia occur between the second and the sixth day.

The *heart* has often an appearance of perfect health, but, in cases where death has occurred from general blood-poisoning, its muscular tissue is soft and friable, and contains scattered extravasations of blood. Under the microscope the muscular fibres show signs of fatty degeneration, and the blood is fluid and tarry. In other cases the opposite condition is sometimes found, coagula of considerable size being met with in the cavities of the heart and in the large vessels. Of late years, indeed, the *cardiac complications* of diphtheria have been the subject of considerable discussion among the French school. Dr. Richardson³ was the first to call attention to the existence of coagula in the heart in fatal cases of diphtheria, but he attributed their formation to an excess of fibrin in the blood. The same explanation of the phenomenon was put forward two years later by M. Beau,⁴ but in 1864 Dr. Meigs⁵ traced an analogy between the intra-cardial

¹ Jenner : Loc. cit. p. 38.

² "Gazette hebdom." 1864.

³ Richardson : "Med. Times and Gazette," March 8, 1856. "Brit. Med. Journal," February 16 and April 7, 1860.

⁴ Beau : "Gazette des Hôpitaux," April 10, 1858.

⁵ "American Jour. of Med. Sci." April, 1864.

coagulation and the fibrinous deposit in the throat, and assumed the previous existence or concurrence of an acute endocarditis, a supposition, however, which he was unable to prove by direct observation. In 1872 Dr. Beverley Robinson¹ put forward, as the result of a careful comparison of many accurately recorded cases, the view that cardiac thrombosis is of very frequent occurrence in cases of diphtheria, and is a very fertile cause of their fatal termination. He also described in detail the physical signs by which its occurrence might be diagnosed during life. Mr. Robinson's views have been combated with considerable energy by M. Callandreaudufresse,² who admits that coagula are found post-mortem in at least half the fatal cases of diphtheria, but denies that they are the immediate cause of death. Out of forty autopsies he did not succeed in finding a single case in which the fatal issue could be traced solely to cardiac thrombosis. The most important researches on the subject, however, are those of M. Labadie-Lagrave,³ whose views are a distinct advance on those of former authors. His conclusions, which are deduced from a comparison of 100 carefully-recorded cases, are briefly as follows:—In nearly half of the fatal cases of diphtheria the heart shows signs of having been the seat of an acute endocarditis, resulting in vegetations and fibrinous deposits on the valves. The part most usually affected is the upper surface of the mitral valve, which is reddened, and presents at a distance of some millimetres from its free border a festoon of minute granulations of a bright red colour, the valve itself appearing swollen and opaque. On microscopic examination the morbid process can be traced into the layer of flattened cells which correspond to the upper surface of the valve, the interstices between them being filled by spherical embryonic cells arranged in parallel lines. The lining membrane of the auricles is occasionally the seat of a similar change. The

¹ Beverley Robinson : "Thèse de Paris." 1872.

² Callandreaudufresse : "Thèse de Paris." 1873, No. 37.

³ Labadie-Lagrave : Loc. cit.

process does not end here, but leads in its turn to a general dispersion of emboli throughout the circulation. Thus the lungs are frequently found to present scattered hæmorrhagic infarctions, due to arterial and capillary embolism, as well as minute venous thromboses between the lobules. Hæmorrhagic infarctions are also found beneath the pericardium, in the muscular substance of the heart, and in the subcutaneous cellular tissue. The pia mater, the venues of the dura mater, the substance of the brain, the liver, and other organs are the seat of venous thromboses. In the most malignant cases of the disease the cardiac muscle is frequently found degenerated, while occasionally the lining membrane of the small arteries is inflamed, and the kidneys are the seat of parenchymatous changes. These lesions are almost always associated with an excess of white cells in the blood, and in the severer cases the leucocytosis is very marked. According to M. Lagrave the endocarditis of diphtheria is the antecedent of the cardiac thrombosis described by other authors, but while the latter manifests itself during life by unmistakable signs, the former is often extremely difficult to discover. In the more rapid cases of cardiac thrombosis, the symptoms declare themselves in the most unexpected and alarming way. The little patient suddenly sits up in bed, flings himself about, and throws the clothes off; his face is pale, and his features drawn, while his eyes are expressive of the greatest agony. The cardiac contractions at the first onset are loud and tumultuous, but they gradually become muffled, irregular, and intermittent, and the heart seems every moment about to stop beating. The pulse is thready and irregular, and the jugulars are gorged and prominent. There is extreme dyspnoea, which steadily increases, till the patient succumbs after from two to six hours from the first attack. When the coagula form slowly, the symptoms are of a similar character, but much less marked. It is only fair to state that M. Lagrave's conclusions have not met with general acceptance, and it has

been stated on the authority of M. Parrot¹ that the granulations described have no relation to any inflammatory process. For the present, therefore, it would appear that the part played by cardiac complications in diphtheria, is one which still requires much elucidation by further research and observation.

The *spleen* and *liver* are often perfectly natural, but occasionally they are much engorged, and sometimes their capsules present extravasations of blood. The inner surface of the *stomach* may be the seat of ulcers and sloughs, and hæmorrhagic exudations are occasionally met with, both in that situation and beneath the lining membrane of the intestines and bladder. The *kidneys* present marked changes in about half the fatal cases of diphtheria. They are generally swollen and engorged, and often contain scattered collections of blood. In other cases the changes are only visible under the microscope. Here the epithelial cells lining the tubules are found swollen and granular, and they have often undergone extensive proliferation, the crowded masses of young cells filling the tubes, and forming epithelial casts. Occasionally the Malpighian tufts and the tubules contain blood, and the latter are sometimes occupied by hyaline coagula.

The changes in the *brain* depend on the mode of death, and, if the patient succumbs to asphyxia, there is venous engorgement of the membranes and cerebral substance, and minute extravasations of blood. Pus and lymph have also been found on the arachnoid membrane, when the septicæmia has been very marked. In many cases where death has taken place whilst the patient was suffering from extensive diphtheritic paralysis, the tissues have presented no marked alterations;² and Morelli³ goes so far as to say that "the anatomico-histological changes found in such cases are inadequate to explain the

¹ Beau-Verdeney: "Thèse de Paris." 1874, No. 136.

² See two cases reported by Dr. Hermann Weber: "Virchow's Archiv." vol. xxiii. p. 115.

³ "Lo Sperimentale," Decembre, 1872.

various forms of diphtheritic paralysis and paresis." In fact, the almost invariable restoration of the functions would seem to argue conclusively against the muscles or motor nerves being the seat of any serious degenerative change. In exceptional cases, however, serious and extensive lesions have been discovered. They were first observed by Charcot and Vulpian¹ in a case of paralysis of the velum palati. The motor nerves of the part consisted of tubules emptied of their medullary substance, their neurilemma containing numerous granular cells, elliptical in form, and in some instances, nucleated. In one case Buhl² found the substance of the brain occupied by scattered extravasations of blood, the nerves thickened at their roots, and their sheaths crowded with lymphoid cells and nuclei. In a case of Oertel's³ the muscles had undergone extensive fatty degeneration, while the substance of the brain, spinal cord, and spinal nerves was the seat of numerous extravasations of various dates. There were also other marked changes in the spinal cord. Dr. Hughlings Jackson⁴ has pointed out that muscles supplied in part through ganglia of the sympathetic system are especially prone to paralysis. This is true of diphtherial amaurosis, and of the paralysis of the palate, and it would seem that the nerve-cells which give way are most largely represented in the higher ganglia of the sympathetic systems.

The most cursory study of the general pathology of diphtheria suffices to assure us that it is an acute general disease, with certain local manifestations. The *primary septicæmia* is due to the specific poison, but absorption from the decomposing lymph is no doubt a cause of *secondary infection*. In all cases the attack is associated with some degree of constitutional disturbance, while in the severest forms there is

¹ "Compt. Rend. de la Soc. de Biol." 1862.

² Ziemssen's "Cyclopædia," vol. i. p. 656.

³ Ibid. p. 657.

⁴ Loc. cit.

extreme disorganization of the blood and consequent implication of nearly every tissue in the body. The general infection is shown at a very early stage, as well as at a period when the local manifestations have disappeared. Besides the constitutional disturbance by which the attack is ushered in, there is the frequent derangement of the renal function, the marked prostration of strength, the functional disturbance of the heart, and at a later period the extensive implication of the nervo-muscular system. The local symptoms—the false membrane with its parasitic growths—must be looked upon as the first evidence of constitutional poisoning, in fact, as the first of the secondary phenomena.

CHAPTER VII.

PROGNOSIS.

THE mortality of diphtheria varies chiefly according to the age of the patient and the character and stage of the epidemic, and these points must consequently be borne in mind in giving a prognosis. The relative proportion of deaths to cases is by no means constant.¹ In some epidemics it has exceeded 50 per cent. According to Dr. Borgiotti's statistics¹ of the recent Florentine epidemic, out of 1,546 persons attacked in the years 1872 and 1873 881 died; but as Dr. Borgiotti elsewhere² remarks, owing to the incompleteness of the health-returns, or, in other words, the probable omission of slight cases, these figures should be looked upon rather as the relation of "the *gravely affected* to the *dead*."

The dangers which are most to be dreaded at the outset of an attack are, on the one hand, extension of the disease to the larynx, and, on the other, severe blood-poisoning. In the former case the patient is exposed to imminent risk of death from asphyxia. In the latter a fatal result may occur from collapse, or the patient may rapidly sink with typhoid symptoms. At a later period, a fatal result may be brought about by repeated attacks of syncope, by general prostration without manifest cause, by exhaustion from constant and uncontrollable vomiting or from severe hæmorrhages, or by inflammatory complications such as secondary pneumonia or acute nephritis. In the case of infants death has resulted from inability to suck, owing to implication and consequent

¹ Loc. cit.

² "Atti dell Accademia," &c. p. 16.

stoppage of the nasal passage. Death during convalescence most commonly results from paralysis of the heart, or of the muscles of inspiration, or from intercurrent disease of the lungs or pleura, or from general failure of nerve-force and exhaustion.

With regard then to the data on which a prognosis must be formed, the most important *general* consideration is the character and mortality of the prevailing epidemic. It may, perhaps, be laid down as a rule that of the cases in which a definite false membrane is present, one-third at least will probably prove fatal. Apart from other less known causes, the mortality in any epidemic will vary according to the form of the disease and according to the proportion of children to adults attacked, diphtheria being, for obvious reasons, far more fatal amongst children than adults. It must also be borne in mind that in certain families diphtheria has an exceptional tendency towards a fatal result. With regard to the *special* symptoms on which to found a prognosis, the following considerations chiefly deserve attention: High temperature, extreme prostration, hæmorrhages, or urgent vomiting at the commencement of an attack are signs indicative of extensive general infection, and must therefore be looked upon as of very serious prognostic import. Valuable information may be gained from the character and extent of the false membrane. *Ceteris paribus*, the prognosis is serious in proportion to the thickness and extent of the exudation. When the exudation shows a disposition to extend rapidly the danger is very considerable, as the extension is most likely to take place in the direction of the larynx. Prostration and a tendency to syncope are alarming signs at any period of an attack: their advent is often heralded by a very rapid or a very slow pulse, with muffling of the heart's sounds, and intermittency of its pulsations. The presence of albumen is not, as I have already pointed out, a symptom of much importance. During convalescence the extension of muscular paralysis to the muscles of respiration is the most alarming sign.

CHAPTER VIII.

TREATMENT.

THE symptoms of diphtheria are due, as I have shown, in part to a general blood infection, and in part to a local specific inflammation. Each of these pathological processes appears to run a cyclical course; in each the deviation from health is only a temporary one, which after lasting for a variable period, shows a tendency to subside and to terminate in the re-establishment of normal action. Each process, however, is attended with its own special danger, which may lead to a fatal issue, before the return to health. As regards the general condition it is the *intensity* of the morbid changes which constitutes the great danger; locally, the risk lies in the *occurrence of the exudation in a perilous situation*.

General Treatment.—This should be directed towards husbanding and supporting the patient's strength by every available means. He should be placed, if possible, in a large, cheerful, and well-ventilated room, the air of which must be at once warm and moist. The temperature should be kept as nearly as possible between 60° and 65° Fahr. The patient's diet must be both nutritious and digestible. Concentrated beef-tea, or beef-tea jelly, milk, and egg-flip must be regularly given at short intervals. Dr. Massei¹, who has seen a great deal of the disease at Naples, has pointed out that milk is often digested with difficulty in these cases, and under such circumstances it must be combined with lime water. Especial attention must be paid to feeding during the night, when the vital power of the patient is usually at its lowest ebb. There is often great

¹ "Intorno alla Cura dell'Angina Difterica." Napoli, 1875, p. 54.

distaste for food ; in other cases swallowing is attended with considerable pain, while occasionally everything that is swallowed is immediately rejected. It is, however, the duty of the attendants to secure the due nourishment of the patient in spite of every difficulty. There are few cases of diphtheria in which systematic feeding does not constitute the most important part of the medical treatment. The administration of alcohol in small quantities is almost always advisable. In some cases, it is true, it may not be called for during the whole of the attack, but very often it supplies us with the best chance of saving the patient's life, and it must then be pushed with a boldness rarely needed in other forms of disease. Small doses of alcohol will usually be found sufficient in the earlier stages of an attack ; two ounces of brandy or four ounces of wine in the twenty-four hours may be prescribed for an adult, and proportionate quantities for a child. In other cases, however, larger doses are required from the very commencement. But whatever be the earlier symptoms the physician must always be prepared to increase the dose rapidly, if the appropriate indications—attacks of syncope, irregular, very frequent, or very slow pulse, and delirium—present themselves. In these circumstances a high temperature does not in itself contra-indicate the employment of stimulants. In all cases it is necessary to keep a careful watch upon the pulse, which will give invaluable information as to the need for alcohol. Rapid and fatal failure of the heart often supervenes quite suddenly and unexpectedly, and the first indication of such failure is the signal for the unsparing use of the drug. Patients suffering from the exhaustion and prostration of diphtheria bear large amounts of stimulant without any of the usual intoxicating effects, and as much as twenty ounces of brandy have been given to an adult within twenty-four hours with manifest benefit. Champagne may occasionally be substituted for brandy, but this wine, in the active state of the disease, often causes pain in deglutition, and, as a rule, is

more useful during convalescence. Whenever there are signs of approaching cardiac failure, it is important to keep the patient in bed with his head low, and to interdict any movement whatever. The neglect of this precaution has often been attended with fatal results.

Before passing to the strictly therapeutic treatment it is necessary to make a few remarks on blood-letting. It was at one time thought that general bleeding had a favourable influence on the spread of the exudation. Home strongly advocated it, and recommended in addition the application of leeches to the upper part of the throat. Bretonneau invariably used the lancet in his earlier cases. But experience soon taught him that depletion neither extinguished the disease nor prevented the formation of false membrane, and he reluctantly abandoned it. Guersant, Trousseau, Bouchut, and Empis all came to a similar conclusion, and since their time the treatment by venesection has not been revived. Considering the serious danger of death from syncope and exhaustion to which patients are exposed when suffering from diphtheria, it is a matter for wonder that such treatment was ever thought of. The same may be said, with scarcely less emphasis, of local depletion. The application of leeches to the throat may indeed relieve the pain and swelling, but such relief is dearly bought at the loss of even small quantities of blood, and the serious risk of diphtheritic infection of the leech-bites.

Sir William Jenner¹ recommends that the treatment should be commenced with a purgative, the bowels being well cleared out by a dose of calomel and jalap or by a calomel and colocynth pill, followed, in the inflammatory form of the disease, by a saline aperient. Mr. De Berdt Hovell,² of Clapton, unaware of Sir William Jenner's observations, has also adopted this plan, and has employed it occasionally for the last twenty years with marked success.

¹ Op. cit., p. 66.

² Mr. Hovell's views on this point will shortly be published *in extenso* in one of the medical journals.

He considers that elimination of the poison is thus made to take place by the intestinal canal, and that the extension of false membrane is arrested.

Of the general remedies which have been recommended in diphtheria there are four kinds, viz. : (1) The recuperative agents ; (2) the alleged specifics ; (3) the antiseptics ; and (4) the expectorants. Some remedies, it will be at once perceived, belong to more than one of these divisions.

(1.) Of the *recuperative agents* iron and quinine are the most entitled to consideration. Of these iron is undoubtedly the most useful, and the profession is indebted to Dr. Heslop,¹ of Birmingham, for proving its value in diphtheria. It should be administered frequently and in large doses. Thirty minims of the tincture of the perchloride may be given to adults every two or three hours, and proportionate doses to children. It is well to combine it with glycerine, and, of course, it must be diluted with water. The general effect of the drug is often extremely favourable, and its local influence is equally well-marked, the soreness and pain in the throat being considerably relieved after each dose. The double effect is more surely procured by prescribing one of the persalts in preference to the less astringent protosalts. Quinine is occasionally required in the course of an attack of diphtheria. The special indications for its use are headache with high temperature, vomiting, and the symptoms of septic poisoning. In such cases the drug should be given in full doses, and should not be persisted in if benefit fails to result in thirty-six or, at the most, forty-eight hours. As a rule, however, quinine is more useful after the more serious symptoms have abated, when it may be very suitably combined with iron and a mineral acid. Morphia and chloral are occasionally necessary to combat continued sleeplessness, and to ward off the exhaustion which is its invariable consequence.

(2.) The principal *alleged specific remedies* are : mercury, sulphide of potassium, bromine, and the balsams of copaiba and cubebs. The treatment of diphtheria by mercurials was at one time not less common than the practice of depletion, and it received a certain degree of support from the favourable influence which dusting with calomel is found to exert on diphtheritic wounds. But experience has long taught us that the general influence of mercury on the system rather promotes than checks the spread of the exudation. At one period mercury was vigorously pushed by Bretonneau,¹ but with very unsatisfactory results. From that time the use of mercury has been gradually discarded, and with such general consent that no one has since ventured to re-introduce it. Of the other alleged specifics, sulphide of potassium has long been regarded by Swiss physicians as a valuable specific, but it often produces both sickness and diarrhœa, and should not be employed. Bromine, which is best administered in the form of bromide of potassium, has not answered the expectations of its first advocate.² The well-known action of copaiba and cubebs on the mucous surfaces, led Dr. Trideau³ to try these remedies in croup and diphtheria, and his experiments have been still further elaborated by Bergeron.⁴ Dr. Beverley Robinson⁵ has also lately strongly recommended the use of cubebs in the catarrhal form of diphtheria. This physician lays great stress on the importance of making use of the freshly-ground powder. In catarrhal cases I have found distinct benefit from the use of the *perles* of copaiba. None of the various drugs just enumerated, however, can legitimately lay claim to anything like a certain and specific action.

¹ New Sydenham Society's "Memoirs on Diphtheria." London, 1859, pp. 77-93.

² Ozanam : "Comptes Rendus de l'Académie des Sciences." 1856.

³ "Traité de l'Ang. Couen. par le Baume de Cop. et le Poivre Cub." Paris, 1866.

⁴ "Dict. de Méd. et de Chir. Prat." t. x. p. 361.

⁵ "American Journal of Med. Science." 1876, p. 30, et seq.

(3.) The *general antiseptics* include iron, chlorate of potash, carbolic acid, and salicylic acid with its compounds.¹ The value of iron has already been explained. Chlorate of potash, so useful in many affections of the throat and mouth, has also been largely used in diphtheria. Isambert² and Sceligmuller³ have carefully studied the effects of this drug, and the general weight of evidence is very much in its favour. Ten to twenty grains may be given every two or three hours. I have not employed carbolic acid myself as an internal remedy, but the sulpho-carbolates as recommended by Dr. Sansom⁴ have often proved of service in my hands, in the *secondary* poisoning of diphtheria. In the *primary* septicæmia, these remedies have appeared to me quite useless. Five grains of the sulpho-carbolate of soda in a little water may be given to a child of two years every three or four hours. Salicylic acid has been strongly recommended by Fontheim,⁵ and I have used it myself in three cases with apparent advantage. The following is the formula which I have employed:—R. Acid. salicylic. ʒiiss.; spirit rect. ʒiiss.; aquam distill. ad ʒvj. M. Ft. liquor. One to two teaspoonfuls of this solution may be given every three hours. Great success is claimed by Dr. Hanow,⁶ of Erlangen, for this remedy administered internally in half-grain doses every hour; but these observations require confirmation. The salicylates of soda and potash have also been strongly recommended. I have given the former remedy in two cases, but in both instances the disease was too far advanced for benefit to result. Salicylate of

¹ The sulphites introduced by Polli ("Brit. Med. Journ." vol. ii. p. 441, 1867) have been strongly recommended by Giacchi and Ferrini (whose papers are referred to in the body of the article), but I have not tried them myself.

² "Études Chim. sur l'emploi du Chlor. de Potasse dans les Aff. Couenneuses." Paris, 1856.

³ "L'Union Médicale," 9 Juillet, 1878.

⁴ "The Antiseptic Treatment." London, 1871.

⁵ "Journal für Praktische Chemie." 1875, vol. ii. p. 57.

⁶ "Mediz. Neuigk." Erlangen, May, 1875.

soda and salicylic acid have been recently found useless by Drs. Cadet de Gassicourt and Bergeron respectively.¹

(4.) The use of *expectorants* has long been more or less in vogue. The principal remedies of this kind which have been found useful are senega, carbonate of ammonia, and the balsams. Senega was recommended as an expectorant by Dr. Archer² nearly one hundred years ago. It has since been frequently employed in this country, and is highly esteemed by Dr. West.³ A dessert-spoonful of the officinal infusion, sweetened with a little syrup, should be given every two hours, but the effect of the remedy should be watched, and the quantity reduced if any vomiting occur. Carbonate of ammonia (two or three grains) may be given with the senega, or it may be administered in water. The balsams of copaiba and cubebs, though placed under the list of alleged specifics, probably act in a great measure as expectorants.

Local Treatment.—This has varied greatly at different times, and there still exists considerable divergence of opinion as to which method is most appropriate. Caustics and astringents, solvents and antiseptics, heat and cold, have all been in favour at different times and with different observers.

The use of *caustics* has, perhaps, been more general than that of any other class of local application. Bretonneau⁴ strongly recommended a mixture of hydrochloric acid and honey, in the proportion of one part of the former to three of the latter, as a means of checking the local exudation. The caustic was to be applied only once in twenty-four or thirty hours, and its effects were to be carefully watched. Subsequent experience has shown that besides being attended with very considerable pain, the use of strong hydrochloric acid has no effect in controlling the spread of

¹ "L'Union Médicale," 9 Juillet, 1878.

² Op. cit.

³ "Diseases of Infancy and Childhood." Sixth edit. London, 1874.

⁴ "Memoirs on Diphtheria" (New Syd. Soc. Trans.). London. 1859.

false membrane. The use of a solution of nitrate of silver, and even of the solid stick, at one time met with considerable support, and has been recommended by Bretonneau, Guersant, Bouchut, and Trousscau,¹ but it is being gradually abandoned by those who have had experience of recent epidemics. The same remark is true of sulphate of copper, and the acid nitrate of mercury, both of which have been recommended for the local treatment of diphtheria. In fact, the profession has given up the use of caustics altogether, being convinced that they rather aggravate, than check, the local process.

Various *astringents*, such as tannic acid, powdered alum, and perchloride of iron, have been used for many years, and still are largely employed. Tannic acid and alum are most conveniently administered by insufflation. Their effect is increased, as Dr. Loiseau² has pointed out, by using them alternately. Half a grain of tannin with half a grain of starch will be found the most convenient strength, whilst alum may be employed in the proportion of three-quarters of a grain of the salt to a quarter of a grain of starch. Insufflations are recommended to be used (by those who believe in their beneficial action) at least every hour or two. Perchloride of iron is best employed in the form of the tincture, which should be freely applied every two or three hours. The disease is sometimes checked by this class of remedies, but on the other hand, it sometimes irritates the throat—especially if there is much hyperæmia—and frequently increases the nausea and dislike to food which are so common. I now seldom use these drugs, with the exception of iron, which, when employed as a constitutional remedy, also acts topically.

Local agents which act as *solvents* have been introduced in modern times in diphtheria, with the view of getting rid of the false membrane without violence. The chief of these

¹ "Memoirs on Diphtheria" (New Syd. Soc. Trans.). London, 1859.

² "Gazette Médicale de Paris." 1862.

are : lime-water, solution of caustic potash, chlorate of potash, and lactic acid. Added to pieces of detached membrane in a test-tube, each of these substances has certainly the power of dissolving them; and whilst the false membrane is in contact with the living tissues, they have a similar, though less active, effect. Lime-water has been particularly recommended by Steiner,¹ and is certainly useful when the false membrane is not very thick. Sanné² has recently suggested a saccharate of lime, which has the advantage of being a more stable compound than lime-water. These preparations of lime can be applied either in the form of spray or by means of a camel's-hair pencil. Liquor potassæ (one part of the liquor to four parts of water) can also be used in the same way. Of all the solvents, however, lactic acid is the most reliable. I generally apply it freely with a brush, or by means of a piece of lint attached to a wooden rod; the latter instrument permits of very free application. I have never met with the inconvenient results from the use of lactic acid which Küchenmeister³ has described—viz., ulceration of the mucous membrane of the lips and mouth.

In most cases of diphtheria *antiseptics* are very useful. The best antiseptics are carbolic acid, permanganate of potash, chlorinated soda, glycerine of borax, chlorate of potash, and hydrate of chloral. Carbolic acid may be applied in solution (gr. iij. to ℥j.), or in the form of Glycerinum Acidi Carbolici, B.P.,⁴ or the Vapor Acidi Carbolici of the Throat Hospital Pharmacopœia, may be used. Dr. Massei⁵ specially

¹ "Zur Therapie der Diphtherie,"—"Jahrbuch für Kinderheilkunde," 1870.

² Op. cit. p. 429.

³ "Die Behandlung der diphth. Angina durch zerstäubte Milchsäure." Dresden, 1870.

⁴ Dr. Sansom has, however, shown that the antiseptic qualities of carbolic acid are greatly diminished by the addition of glycerine (Op. cit. p. 20, et seq.)

⁵ Op. cit. p. 43.

recommends the use of the alcoholized carbolic acid, the carbolic acid being in proportion to the alcohol as 1 to 3, or 1 to 5, according to the severity of the local exudation. Permanganate of potash is most serviceable when employed at the strength of gr. v. to ʒj. The best formula for chlorinated soda is: *Liquor sodæ chloratæ* ʒiv., *aquæ* ʒxx. Chlorate of potash may be given in almost any strength, though gr. xx. to ʒj. is generally found sufficient. Hydrate of chloral has also been found very serviceable by several practitioners. It was first recommended by Dr. Accetella,¹ and subsequently by Dr. Ferrini,² of Tunis, and has since been highly extolled by Dr. Cæsare Ciattagli,³ of Rome, and Dr. Massei,⁴ of Naples. In this country it has been employed with great success during the last two years by Mr. Hughes Hemming, of Kimbolton, to whom I am indebted for its recommendation. Mr. Hemming uses the syrup of chloral (gr. xxv. ad ʒj.), and directs that it should be employed every hour or two. It does not, as a rule, cause any pain, and the nurse can be easily taught to apply it. Mr. Hemming observes that, "whilst it rapidly gets rid of the fœtor, it is beautiful to see the membrane loosen and come away, leaving a healthy surface underneath." This remedy has also been very successfully used by Dr. Charles Hemming, of Bishops Waltham.

Jodin⁵ first recommended sulphur as a local agent, and it has since been administered internally. The following Italian physicians speak favourably of it: Nesti⁶ found insufflations of sulphur a most efficient remedy in the Florentine epidemic, and Dr. Calapinto⁷ used the flowers of sulphur, mixed with honey, with great success. Dr. Stefano Becchini⁸ also speaks favourably of its employment.

¹ "Campania Medica." No. 12, 1873.

² "Storia Clinica della Difterite osservata nella Città di Tunisi negli anni 1872-73." (Lo Sperimentale, Luglio e Settembre, 1874.)

³ "Gazzetta Medica de Roma." Maggio, 1876.

⁴ Op. cit.

⁵ Loc. cit.

⁶ Op. cit. (Nella 2^a parte).

⁷ Il Morgagni, II. e III. 1873. ⁸ Lo Sperimentale, Febbraio, 1873.

Several practitioners, however, who have employed it, have informed me that it has not answered their expectations.

One of the solutions¹ above mentioned should be perseveringly employed in all cases of diphtheria where there is much false membrane. The antiseptic may be used either as a gargle or a spray ; or the patient's mouth may be washed out with it by the attendant. In this way the horrible fœtor of the breath, which is so common in diphtheria, will be prevented. It must not, however, be expected that the use of antiseptic solutions will have any restraining influence on the exudative process, though it may, to some extent, destroy the parasitic fungi so frequently present in the exudation. There is also a class of remedies which, though not strictly speaking antiseptic, still by exclusion of air from the false membrane appears to have antiseptic influence. These are, in fact, *varnishes*, and consist of gummy matters dissolved in a fluid which evaporates quickly. I have tried gum benzoin, gum tolu, mastich, and resin. These substances can be dissolved in rectified spirits, or in ether, or a tincture of the gum or resin may be mixed with ether. On the whole I prefer the ethereal solutions (1 in 5), and tolu is most pleasant to the patient, and, lasting longest as a varnish, has to be least frequently re-applied. The surface of the false membrane should be dried with blotting-paper² before the application is made.

There yet remain two local applications to be considered, viz., ice and steam.

In many cases the patient will derive great comfort from frequently taking a piece of *ice* into his mouth. The annoying

¹ In the late epidemic at Highgate, boracic acid, dissolved in glycerine (1 in 30), was found very serviceable by Dr. Simpson and others. It was applied first, hourly, and afterwards every two hours, until the membrane ceased to re-form.

² For holding the blotting-paper a miniature paper-clip, which can be fixed at different angles to a long stem, is sold by Messrs. Mayer & Meltzer, 71, Great Portland Street.

dryness and heat of the throat, as well as the dysphagia, will be thereby materially alleviated, and the inflammation sometimes arrested. The application of ice to the neck in a bladder or ice-bag is sometimes agreeable, and probably generally beneficial. The use of ice is especially indicated in the first stage of the disease, particularly in those cases where there is much inflammatory tumefaction.

On the other hand, heat is a very useful agent when the false membranes have attained any considerable degree of thickness. Hot fomentations applied externally to the throat are often found to relieve the pain in a remarkable way, while the use of *steam* inhalations appears to exercise an extremely favourable influence on the local process. As a vehicle for conveying a volatile medicament, steam has been recommended by many physicians, but as a remedy in itself for diphtheria it was first suggested by Dr. Prosser James.¹ The theory on which it is now used, however, is due to Oertel,² who has earnestly advocated the employment of steam on scientific grounds. When it is found impossible to check the formation of lymph by the use of local remedies, the rational treatment is to convert, as far as we can, the inflammatory into a suppurative process. Such a transition invariably takes place before the return of normal conditions, and to promote this transition is equivalent to hastening the restoration of health. Oertel has found that the internal use of moist warmth facilitates the occurrence of suppuration more than any other agent, and he recommends repeated inhalations of hot vapour. He has observed that at the end of from twelve to eighteen hours, during which the inhalation has been practised hourly or half-hourly for ten or fifteen minutes each time, the margins of the diphtheritic deposits, which previously passed imperceptibly into the surrounding tissue, become more sharply defined, and contrast strikingly with the intensely reddened mucous membrane.

¹ "Sore Throat." 1861, p. 39.

² Ziemssen's "Cyclopædia," vol. i. art. "Diphtheria," p. 675.

The patches, therefore, at first sight seem enlarged. Besides this; the operation of the hot vapour has been to induce a considerable excretion of pus corpuseles. If the inhalations be continued, the false membranes will be seen to become gradually thicker and raised up from the mucous membrane. At the same time they change in colour, and their surface becomes wrinkled and uneven. After some days they are completely detached, and the mucous membrane is healthy, except for a variable degree of catarrhal inflammation. The inhalations may be made to serve another purpose, viz., that of cleansing and disinfecting the mouth, and with this object the Vapor Aëdi Carbolici, or Vapor Pini Sylvestris (Throat Hosp. Ph.) may be used.

As young children cannot generally be induced to inhale the steam from an inhaler, "a croup-tent" should be erected over the cot for this purpose. An excellent portable apparatus¹ has been made for me by Messrs. Mayer. When the parts of the tent are put together, and a blanket thrown over it, it represents, on a small scale, the upper part of an old fashioned four-post bed (with the curtains drawn) such as is still common in the country. The tent method of administering inhalations has been in vogue at the Children's Hospital for many years.² The steam-kettle³ should then be placed near the tent, and steam passed within it.

The detachment of the false membranes, which has by some been advocated as a preparatory step to the application

¹ The "portable croup-tent" consists of eight metal rods. Two of these representing the length of the tent are four feet long, and two representing the width are two feet six inches long. The four supports are two feet four inches in height. The eight pieces screw together, and when separated can easily be carried in the hand. A special cloth or blanket, sold with the frame-work, completes the apparatus. The croup-tent is exceedingly useful, not only in cases of diphtheria and true croup, but also in laryngitis stridulosa, for saturating the atmosphere with the fumes of nitre and stramonium.

² Jenner: Op. cit. p. 83.

³ An excellent steam-kettle is sold by Messrs. Allen, of Marylebone-lane.

of remedies, cannot be recommended, except in cases where it may be necessary for the relief of urgent dyspnœa, or where putrefying membrane is lying loose in the throat. As a rule, the false membrane, when thus removed, rapidly reappears, and often with increased activity and over a wider area.

The above are the modes of treatment and kinds of remedies which are suitable in different forms of diphtheria. Many others might have been enumerated. As in the case of all diseases which are very fatal, a vast multitude of remedies have been most enthusiastically recommended, but have referred to those only which I have myself tried.¹ It will perhaps give a more precise idea of the management of the disease if we suppose a certain typical case before us, and go through the various phases of treatment that may be required :

A child is attacked with a sore throat during an epidemic of diphtheria, and an examination of the fauces shows that the disease has already commenced, thin patches of false membrane being present. The little patient should at once be put to bed in a large, well-ventilated room, and should be made to suck ice constantly, whilst a bladder of ice should be applied to the neck. A simple but highly-nourishing diet of beef-tea, eggs, &c., should be ordered, and stimulants as a rule be given from the very commencement. If there be evidence of primary blood-poisoning, twenty to thirty drops of the tincture of perchloride of iron and the same quantity of glycerine and five to ten grains of chlorate of potash, in half an ounce of water, should be administered every three hours ; if, on the other hand, the catarrhal symptoms be very marked, the balsamic treatment should be tried, and a capsule or *perle* of copaiba containing four minims of the balsam should be given every four or six hours. Local solvents should now be employed, and the throat should be sprayed every two or three hours with lactic acid solution, or, if the child will not allow this to be done, the

¹ Bromine and sulphide of potassium as general remedies, and chloral hydrate as a local antiseptic, are almost the only exceptions to this statement.

pharynx must be forcibly swabbed with this remedy, or the syrup of hydrate of chloral may be applied in the manner already advised. If, in spite of this treatment, the disease advances; and the false membrane becomes thick and abundant, it should be painted with an ethereal solution of tolu (1 in 5), the surface of the false membrane being first dried with blotting-paper. This application, if thoroughly made, need not be applied more than once, or at the most twice, a day. Ice should now be given up, and warm inhalations, made antiseptic from time to time, constantly employed, by means of the croup-tent, in order to bring about suppuration and cause the false membrane to separate by the normal pathological process. It is useless continuing the copaiba any longer, and the iron often appears to lose its effect. It is at this period that the sulpho-carbolates sometimes have a wonderfully beneficial effect, and at this stage also quinine, in large doses, may be given at the same time with advantage. If the disease extend to the larynx or nose, the appropriate treatment hereafter detailed should be pursued. The third stage being characterized in favourable cases by the natural tendency to the separation of false membrane, the hot inhalations must be industriously continued, whilst the patient's strength is kept up by the use of highly nutritive drinks and stimulants. Such is the plan of treatment that may be pursued in an ordinary case of diphtheria. Complications of course require special remedies, and the sequelæ need appropriate restorative measures.

The impaired innervation of the lungs, which proves fatal in so many cases of diphtheria, is difficult to cope with. The most reliable measures consist in the assiduous administration of food and stimulants. The inhalation of weak ammonia has been recommended to meet this condition.

During convalescence the patient must still be carefully watched. The weakness and anæmia are best treated by iron and other tonics, by cod-liver oil, and by residence at some bracing watering-place. These measures are also appropriate

in cases of muscular paralysis, but they then require to be supplemented by other therapeutic measures, according to the special symptomatic indication. The slight palsy of the pharynx and soft palate, which is the commonest form of post-diphtherial paralysis, generally passes off in a few weeks without treatment. Where, however, there is marked loss of power of the pharynx, epiglottis, or œsophagus, so that the food is only swallowed with great difficulty, it may be necessary to feed by means of the œsophageal tube; indeed, this procedure may be absolutely necessary to prevent the patient dying from inanition. In less extreme cases the use of the feeding tube will serve to prevent the food from passing into the larynx, an accident which is likely to be followed by inflammation of the lungs, and is always attended with great danger to the life of the patient. Sometimes it is sufficient to feed the patient on thickened liquids. When the paralysis is obstinate, and when it extends to the muscles of locomotion, the employment of electricity is indicated. Both the faradic and galvanic currents are useful, but they should be applied in a mild form. For the extremities, this treatment may be combined with friction and shampooing of the affected parts.

Prophylaxis.—Before concluding the treatment of diphtheria, it may be well to add a few words on its prophylaxis. When inspecting the patient's fauces, or cleaning or changing the tracheotomy tube, the practitioner should be very careful to prevent any of the morbid secretions from coming into contact with his lips or mouth, fatal results having followed the neglect of this precaution. Like precautions should also be impressed upon the attendants who have charge of a case of diphtheria. Orders should at the same time be given that no one but the attendants should enter the sick-chamber except upon urgent necessity; and all linen, spittoons, or other articles which the patient may have used should be carefully disinfected. By adhering strictly to these rules, it is generally possible to prevent the extension of the disease.

CHAPTER IX.

LARYNGO-TRACHEAL DIPHTHERIA,

FORMERLY CALLED

CROUP.

THE term *croops*, or *croup*, has been used popularly in Scotland from an early period. The word "croops" was first employed by Dr. Patrick Blair in 1713, and "croup" by Dr. Home, a little more than a century ago. Since then it has been somewhat vaguely used, both by the public and the profession in all parts of the world to describe a certain train of laryngeal symptoms. The word is probably derived from the crowing breathing, which is such a frequent accompaniment of the disease it was intended to describe. It has many allies in other languages, the closest being the Dutch *Geroop*, a cry; but the following are doubtless all derived from the same root, viz., Icelandic, *Hrøpa*; Anglo-Saxon, *Hreopan*; Gothic, *Hropjan*; Old German, *Hrof*; Modern German, *Ruf*; all words intended to represent the sound of the voice.¹ The Scotch word *Roup*—hoarseness, has the same derivation. On the other hand *croup* may be derived from the Gaelic *crup*, signifying a *contraction*, i.e., contraction of the throat.

History (The Relation of Croup to Diphtheria).—Though the history of diphtheria has been already briefly sketched, it is necessary to make a few remarks to explain how a form of diphtheria came to be regarded as a distinct disease, and to point out how other laryngeal affections have

¹ "Edinburgh Monthly Medical Journal," February, 1856.—
"Observations on Croup," by Charles Wilson.

been and still are—at least in this country—included under the name of croup. In the 17th and 18th centuries diphtheria and putrid sore throat were not differentiated, but were classed together in this country under the head of *Cynanche Maligna*. A few years before Dr. Home published his celebrated work, Ghisi and Starr had described diphtheria as it now exists, but, unfortunately, Dr. Home was not aware of their labours, and there is no doubt but that his “Treatise on Croup” suspended the progress of observation for nearly sixty years, and even now warps the judgment of many accomplished practitioners. Immensely impressed with the laryngeal phenomena¹ of diphtheria, “Francis Home,” as Bretonneau remarks, “persuaded himself that he had just met with an affection which had hitherto escaped the attention of his predecessors, and thought that he ought to give it the popular name under which he found it designated in a Scotch county. The novelty of the discovery was widely diffused, and the new denomination so fascinated all persons that it prevented them from recognizing a disease observed from the most remote antiquity, and which, in our own days, is accompanied by all the symptoms which it has uniformly exhibited.” Until diphtheria appeared in England in 1858 the term croup was employed to describe an acute affection of the larynx, believed to be inflammatory and non-contagious, in which false membrane was present. The tendency of modern investigation, however, is to show that cases formerly described as typical examples of croup were in fact examples of isolated laryngeal diphtheria. French physicians, who since the time of Bretonneau had been more familiar with diphtheria than the profession in this country, almost universally regarded the two affections as identical. When the violent epidemic of diphtheria broke out in England, in the year 1858, it was natural that practitioners should fail to connect the epidemic affection with the typical croup (previously generally isolated or endemic) with which they were familiar. Although the antiphlogistic

¹ Introduction to First Memoir.

theory was on the wane, croup was still described in text-books as a disease requiring active and lowering remedies ;¹ whilst it was soon perceived that diphtheria could only be combated by analeptic treatment. Hence from the very outset an artificial distinction was created in the minds of practitioners.

Whilst the term croup had been strictly applied to the pellicular inflammation of the larynx, many laryngeal affections in which a shrill cough, or a crowing inspiration, was present, had been described as varieties of croup ; and the terms "false croup," "spurious croup," "catarrhal croup" were in common use. These affections, which are still often mistaken for true croup (*see* Diagnosis, p. 87) had still further warped the judgment of the profession as regards the true nature of laryngeal diphtheria. Near the termination of the great epidemic, 1858-62, in this country, the identity of the two affections was, however, advocated by the late Dr. Hillier,² and in my Jacksonian Prize Essay³ (1863), I maintained the same view. The doctrine of identity has subsequently been urged with great earnestness and ability by Dr. Semple,⁴ and his writings must have exercised considerable influence in this country.⁵

¹ Even Dr. Squire, in his able and comprehensive article published so lately as 1866 ("Russell Reynolds' System of Medicine," vol. i. p. 234, et seq.) recommends in certain cases blood-letting to the extent of three or four ounces for a child of four or five years of age.

² "Med. Times and Gaz." April 26, 1862.

³ This essay is in the library of the Royal College of Surgeons, and an extract from it referring to the subject of diphtheria and croup was published in the "Brit. Med. Jour." March 5, 1870.

⁴ "Croup and Diphtheria." London, 1872.

⁵ Most physicians in this country who have had the opportunity of studying the disease in the wards and in the deadhouse now regard croup as a form of diphtheria. At an early period Dr. George Johnson ("Brit. Med. Jour." Feb. 19, 1870) maintained the identity of croup and diphtheria; and later, our great clinical teacher, Sir William Jenner ("Lancet," Jan. 2 and 16, 1875) gave in his adhesion to this doctrine. The renowned Traube, of Germany, had previously accepted the unity theory ("Berlin. Klin. Wochenschrift," No. 31, 1872)

The advocates of the duality theory have based their views (1) on the supposed pathological differences, and (2) on the alleged clinical differences.

(1.) The supposed pathological differences in the structure of the two kinds of false membrane were formerly put forward as matters of great importance. Virchow,¹ the originator of these hypothetical distinctions, though admitting that the diphtheritic exudation was very similar to that of croup, maintained that the former was poured out *into* the substance of the mucous membrane, while the latter was only a coagulation *upon* its surface. On this hypothesis he founded what was once esteemed a most important point in practical diagnosis. The diphtheritic membrane, he asserted, could not be removed without tearing away portions of the underlying tissues, and leaving a bleeding surface. The erupous pellicle, on the other hand, could be easily detached, and the denuded surface would be found quite healthy, with the exception, perhaps, of a variable degree of hyperæmia. Before long, Virchow found himself compelled to surrender this distinction, as it was found in practice that the two forms of exudation passed into each other by insensible gradations. He now changed his ground,² and promulgated the view that death (necrosis) of the subjacent tissues was the characteristic and essential feature of diphtheritic exudation. Practically, however, this distinction was found to be no more satisfactory than the former, for cases came under observation which clinically answered to croup, but in which there was distinct death of tissue. It was also pointed out that the difference in the degree of adhesion of the erupous and diphtheritic exudations *is due to the difference in the structure of the parts on which they are thrown out*. The false membrane is naturally more

¹ "Archiv." 1847, p. 253, et seq.

² "Handbuch der Spec. Path. und Therapie," 1854, vol. i. p. 292. See also "Berl. kl. Wochenschrift," 1865, No. 2.

closely adherent in the pharynx, where the epithelial layers on which it is deposited are not marked off from the subjacent tissues by any definite homogeneous basement membrane. On the other hand, in the larynx and trachea the presence of the basement membrane favours the separation of the lymph. It has thus at length been generally admitted that there are no sufficient naked-eye appearances to distinguish the croupous from the diphtheritic exudation. Nor have microscopical observers met with any better success in their endeavours to differentiate the two diseases. Dr. E. Wagner,¹ who has done the best work in this direction, has openly declared that his preparations of croupous and diphtheritic membranes are very much alike. The diphtheritic deposit he describes as a transparent, homogeneous, lustrous network, the interspaces of which are, for the most part, filled with lymph and pus corpuscles, though some of them are void of contents. The croupous membrane consists of a close network of delicate threads, the meshes of which contain numerous elements resembling pus cells. Wagner, however, differs from many other observers, holding that the network in both cases has its origin in a peculiar fibrinous degeneration of the epithelium, and not in the separation of a coagulable fluid from the blood. Rindfleisch² admits that the pathological process in "pharyngeal croup" is the same as that which takes place in "laryngeal croup," and thus gives in his adhesion to the views maintained in the present article; but in spite of their anatomical identity, he feels bound to oppose any clinical fusion of the two diseases.

It will be seen from a consideration of the above facts that the pathological differentiation of the phenomena must be abandoned. We hence come to

(2) The clinical differences. The supposed differences are

(a) The site of the disease; and (b) its manifestations.

¹ "Archiv. der Heilkunde," 1866, vii. p. 481.

² "Lehrbuch der Pathologischen Gewebelehre." Third Edition, pp. 311-12.

(a) Diphtheria is said to be an affection of the pharynx occasionally spreading to the larynx, whilst croup, it is asserted, is essentially a disease of the larynx or trachea. The fact is, that croup is a disease which commonly commences in the pharynx, and only in about 10 or 12 per cent. of cases originates in the larynx or trachea. Difference of site, moreover, in a constitutional disease does not constitute a specific difference. Cancer is always cancer, whether the pharynx alone, or the larynx alone, is affected, or whether the two parts are attacked at the same time or consecutively, and rheumatism is still rheumatism, whether it affects the heart or the ankle.

(b) As regards the manifestations of the disease :

(1) croup is said to be a local disease, (2) to be a sthenic inflammation, in which (3) the lymphatic glands are not affected ; and (4) in which there is no albuminuria, nor (5) paralysis ; whilst

(1) diphtheria is a constitutional disease, (2) of adynamic type, in which (3) the cervical glands are inflamed, and (4) in which there is albuminuria and (5) paralysis.

To discuss these briefly :—

(1) It is true that in croup the general symptoms are not so severe as when the membrane is thrown out on an extensive portion of the pharynx. This fact admits of ready explanation, on the view that the septic symptoms are in part secondary to the local processes. For whilst the lymphatics of the mucous membrane of the soft palate, of the tonsils, and of the back of the pharynx have very free communications with the numerous glands below the angle of the jaw, the absorbent vessels of the mucous membrane of the larynx and trachea, are conveyed only to the solitary gland just below the greater horn of the hyoid bone, and the small gland at the side of the trachea.¹ There is, therefore, much less liability to general infection when the local process has seized

¹ Luschka : "Der Schlundkopf des Menschen." Tübingen, 1871, p. 156.

only on the latter part. When the primary septic poisoning is powerful the constitutional symptoms are, however, as marked in so-called croup as in diphtheria.

(2) Cases of sthenic croup are very rarely met with, and the same remark applies to diphtheria. On the other hand, there are medical men who assert that bleeding can be employed in diphtheria with success.¹ Hence distinctions based on differences of type in the two diseases can have no weight.

(3) The cervical glands are not often affected in croup, because the mucous membrane of the larynx has no communication with the superficial cervical glands; on the other hand, as stated above, there is an elaborate connection between the pharynx and the lymphatic glands.

[In cancer of the pharynx also the cervical glands are always enlarged, whilst in cancer of the larynx the glands are seldom at all affected.]

(4) In croup albuminuria is often present.

(5) Paralysis is rare in croup, because nearly all the cases terminate fatally, but it is occasionally met with in those that survive.

I have entered into these details because details must always have a certain amount of significance; but it is more satisfactory to look at the question from a broad and philosophical point of view. Classifications are, after all, mere arbitrary arrangements by which knowledge may be placed in an accessible form for further use. The oldest classifications are purely symptomatic. When anatomy came to be mastered we had an anatomical basis for classification, and we are still obliged to make considerable use of this system; but as medical science progresses the disposition is to track disease to its origin, and seek out its hidden causes. Hence we see arising at the present day an etiological classification. The *cause* of disease, when it can be discovered, is now

¹ "Courier Médical," Sept. 7, 1878. Dr. Simorre reports fifty-three cases of diphtheria treated by bleeding! All the patients recovered—most of them in twenty-four hours.

regarded as the essence of its specific nature. The ordinary inflammation of mucous membranes is attended with engorgement of the tissues, and the formation of pus on the surface; under the influence, however, of a certain poisonous contagium the inflammation, instead of being attended with the formation of pus, leads to the exudation of layers of lymph, which become adherent to the free surface of the mucous membrane. This disease is called "diphtheria," and whether the lymph is deposited on the mucous membrane of the pharynx, or larynx, or trachea, or bronchial tubes, or any other mucous membrane, or on a wounded surface, the disease is still "diphtheria." To suppose that there are two kinds of pellicular inflammations of the larynx, one in which the cause is the diphtheritic poison, and the other in which the cause is some other undiscovered influence, is totally opposed to all probabilities.

Etiology.—This has already been discussed under diphtheria.

Symptoms.—The disease develops in three different ways. It may originate in the larynx. This is *typical croup*, and probably does not occur in more than 10 or 12 per cent. of cases.¹ Most commonly it commences in the pharynx, and extends downwards, constituting *descending croup*. Occasionally, but very rarely, it commences in the bronchial tubes or trachea, and ascends into the larynx. This is *ascending croup*. If, as is commonly the case, the disease commences in the pharynx, the practitioner will be constantly on the watch to note the first invasion of the larynx, but in typical croup, or primary laryngeal diphtheria, it is otherwise, and the symptoms of croup have been conveniently divided into three stages.

The first stage is often preceded by slight catarrh. So insidious is the invasion of the disease that the serious character of the child's illness is often quite unsus-

¹ See Sanné: *Op. cit.* p. 195. Sanné gives 142 cases out of 1,172. Compare also Simon: "Nouveau Dict. de Méd. et de Chir. Prat."

pected. The little patient is noticed to be languid and feverish, he is thirsty, and refuses food, and at the same time there is slight hoarseness, which the nurse attributes to an ordinary cold, until her apprehensions are aroused by a frequent, short, dry, shrill cough. The voice, which was at first only a little harsh, very quickly loses its resonant character and becomes a whisper. On examining the chest, both the inspiratory and expiratory sounds are found to be prolonged, and the normal respiratory murmur is lost in the laryngeal stridor which occurs in inspiration. The supraclavicular spaces are usually somewhat more depressed during inspiration than in the condition of health, and the slight difficulty of breathing which is present is more marked during sleep. The pulse now becomes considerably increased in frequency, and the febrile symptoms generally more pronounced. If a laryngoscopic examination can be accomplished, the mucous membrane of the larynx is seen to be of a bright-red colour, and when the disease has existed for a few hours some thin patches of false membrane may be perceived on it. I have often succeeded in seeing the false membrane with the laryngoscope,¹ and still more often have been able to prove that cases of supposed croup were in fact examples of catarrhal laryngitis. The usually pendent position of the epiglottis in children, however, often prevents a satisfactory examination even in those of tractable disposition; and the timidity of early life is in itself often sufficient to render the employment of the laryngoscope impossible. It is most important at this stage of the disease to make a very careful examination of the sputa. Children very often do not expectorate at all, but anything that is brought up must be put into a glass vessel and gently shaken with a little pure water. The mucus dissolves, and flocculi or small shreds of false membrane, if present, become visible.

¹ See also—Semeleder: "Die Laryngoscopie," 1863, p. 42. Türck: "Kehlkopfkrankheiten," p. 172, et seq. Münch: "Wiener Med. Wochenschrift," 1865, No. 10. Gottstein: "Berl. klin. Wochenschrift," 1867, p. 329.

The second stage is characterized by increasing dyspnoea and by the attacks of suffocation which suddenly supervene from time to time. When the attack comes on the child is generally found sitting up in bed, with red and swollen face, and an anxious, terrified look. The nostrils are rapidly working, inspiration is hurried and "croupy," and is evidently performed with the greatest difficulty, all the auxiliary muscles of inspiration being called into play. The voice is almost inaudible, and there is a constant hoarse and stifled cough, without expectoration. The attack generally lasts three or four minutes, and the patient subsides into a heavy sleep which often continues for several hours. Sometimes unmistakable pieces of membrane are thrown up with the cough, a phenomenon which is often most important as a means of diagnosis, as in many children suffering from laryngeal diphtheria there are no patches of exudation to be detected on a casual inspection of the fauces. It is only on careful and persevering examination with the laryngoscope in cases favourable for examination that the membrane, which is the source of all the trouble, can sometimes be recognized adhering to, or perhaps lying loose, in the chink of the glottis, and obstructing the passage of air. Occasionally the vomiting which is induced by the constant fits of coughing, or by the administration of emetics, may lead to the separation and ejection of large pieces of membrane, in which case the urgent symptoms of dyspnoea are often most strikingly relieved. The mode in which separation takes place is exactly the same in the larynx and trachea as in the pharyngeal region; the process, however, is rendered easier by the arrangement of the mucous membrane, which, in the trachea and in the lower parts of the larynx, is separated from the submucous tissues by a distinct basement membrane. But the improvement due to the expulsion of the concretions is generally only temporary; exudation again collects, and the symptoms return in greater intensity than before. At this stage of the disease the pulse

is very rapid, and generally irregular. The little patient is exhausted and is constantly bathed in sweat.

The third stage now supervenes. As the disease advances the suffocation becomes more urgent, and there is *no remission between the attacks, the dyspnœa being constant*, though fearfully aggravated every few minutes. The lips assume a livid colour and the nails become blue. The sternum and the intercostal spaces are forcibly drawn inwards during each effort at inspiration, whilst the agony of impending suffocation is most distressing to witness. The child throws his arms wildly about, or clutches his throat to tear away, as it were, the obstruction, or he thrusts his fingers into his mouth to seize the offending substance. The symptoms of fever are intensified, the thirst is urgent, the tongue thickly furred, and the pulse quicker but weaker. The little patient dies in an attack of dyspnœa or soon succumbs to gradually increasing coma, to syncope, or exhaustion.

Diagnosis.—In children it is sometimes very difficult to distinguish *catarrhal laryngitis*, of a severe form, from croup. Indeed in the early stages it is often impossible to differentiate the two affections. In young children, from the small size of the larynx, and the great tendency to reflex irritation, slight inflammation of the larynx quickly gives rise to spasm, and produces stridulous breathing, *laryngitis stridulosa*, as it is technically called. When, however, the disease is fully developed, the two affections are easily distinguished, for whilst catarrhal laryngitis nearly always ends in recovery, in diphtheria the prospect of a fatal termination is soon apparent. Croup very often commences at night, but catarrhal laryngitis almost invariably comes on at that time; hence we have in the time at which the disease first manifests itself a possible diagnostic sign. It has already been pointed out that the laryngoscope cannot often be successfully used in young children, but the expectoration must be examined in the way already described, and false membrane, if present, will always be detected.

Further, there is a pure neurosis, a spasmodic action of the adductors of the vocal cords, giving rise to *laryngismus stridulus*, which has been called "spurious croup," "false croup," and "nervous croup," with which true croup is sometimes confounded. This disease very frequently comes whilst the mother is suckling, or dandling the child. Carpo-pedal contractions also occur in marked cases of laryngismus, but above all there is *the absolute intermission* of all dyspnœa between the paroxysms; whilst in true croup, when fully established, slight dyspnœa is always present between the attacks of suffocation. Many fatal cases of laryngismus, however, no doubt lose their qualitative affix and appear in the Mortality Returns as simple "croup."¹

Pathology.—The false membrane does not differ essentially from that described in connection with the pharyngeal form of the disease. The membranous exudation is more frequently found on the epiglottis and the ary-epiglottic folds than on the lower portions of the larynx, but occasionally it invests the whole of the lining membrane of the larynx, extends throughout the ventricles, and passes along the trachea to the smallest ramifications of the bronchi. It rarely happens that the lymph is so abundant as to completely occlude the larynx, and in many fatal cases only a very thin, transparent membrane is found. The dyspnœa in croup is primarily due to the inflammatory tumefaction and plastic exudation, which, however, soon gives rise to spasm of the adductors. The muscles are infiltrated with serum, but there is no paralysis of the abductors, nor atrophy of their structure. M. Callandreau-Dufresne² has described these changes in detail. The muscles especially affected are the thyro-arytenoid, which are found pale, friable, and extremely œdematous.

¹ The above considerations tend to show that the substantive use of the word "croup" is altogether objectionable.

² "Thèse de Paris," 1873, No. 87; see also an interesting case recently published by Dr. Baginsky: "Central. Zeitung für Kinderheilkunde," October 1, 1878.

Under the microscope the fibrils are seen to be greatly swollen, and infiltrated with fat cells, while their striæ have disappeared, and the nuclei of the sarcolemma have undergone considerable increase in number. Similar changes are found only exceptionally in the extrinsic laryngeal muscles. The lymph is found more closely adherent in the supra-glottic than in the sub-glottic region, and on removing it the mucous membrane is generally almost normal below the level of the vocal cords, but above that line it is often swollen and inflamed, and sometimes ulcerated. It has already been stated that the membrane which forms in the trachea can be much more easily detached than that which is found in the pharynx. There is nothing special as regards the false membrane in the trachea, which is generally more adherent in the upper than in the lower portion of the tube.

Prognosis.—The prognosis is most unfavourable. Probably not more than 10 per cent. of the patients recover under suitable treatment without tracheotomy. In this country tracheotomy is, comparatively, so little practised in croup—in proportion to the number of cases—that nearly all the remainder prove fatal. If, however, the remaining 90 per cent. were tracheotomized, 66 per cent. might recover according to the most favourable statistics (see page 94), or, according to an average, based on 4,663 operated on in the Children's Hospitals of Paris, 23·91 per cent. Accepting the latter figures, out of 100 cases of undoubted croup we might expect that 68·49 would terminate fatally, and 31·51 recover—10 without tracheotomy and 21·51 (*i.e.*, 23·91 per cent.) after the operation. If the trachea were not opened in the proper proportion of cases the fatality would, of course, be proportionately greater; whilst if the operation were performed earlier than is commonly the case, the mortality would probably be considerably less. The fatal termination may be expected in the first three or four days, certainly within the first week.

Treatment: First Stage.—The child should be placed in a warm, well-ventilated room, an ice-bag should be applied

to the neck, and ice constantly sucked. Spray inhalations of lactic acid (gr. xx. ad ʒj.) should be employed. The inhalations should be given at least every hour, and continued for five minutes at a time. In *the second stage*, or as soon as it is believed that false membrane has formed, emetics must be employed. A number of instances are recorded in which children have been saved from imminent asphyxia by the spontaneous expulsion of false membrane, and this natural mode of cure has sometimes been happily imitated by the administration of emetics. According to Valleix,¹ in thirty-one cases so treated, fifteen recovered, whilst of twenty-two in which this class of remedies was neglected, only one cure resulted. Trousseau concurs with the statements of Valleix. In many cases, however, the relief is merely temporary, the membranes quickly reforming in the larynx, and the dangerous symptoms returning with increased severity. Moreover, the practice is not altogether unattended by danger, for the tracheal membrane may be forced up by the act of vomiting in such a way as to entirely obstruct the passage of air. This risk must be incurred, though valuable time should never be wasted on the use of emetics, when the only alternative is the performance of tracheotomy. Tickling the fauces will occasionally be sufficient to excite the desired action, but as a rule it is necessary to resort to drugs. Cardiac depression is so common an accompaniment of diphtheria that it is unwise to employ any emetic by which it is likely to be increased. Tartar emetic must, therefore, be especially avoided. Strange as it may seem, this drug has in times past been very widely employed in diphtheria. Trousseau,² indeed, strongly condemned its use, terming it the most dangerous of all emetics. But Bouehut,³ as late as 1859, published three cases in which he attributed a successful issue to the energetic employment

¹ "Guide du Méd. Prat." t. i. Art. "Diphthérie."

² Trousseau : Op. cit. vol. ii. p. 578.

³ "L'Union Médicale," April 5, 1859.

of tartar emetic. His example should not be followed, especially as we have at our command emetics which are not less certain in their action than antimony. Should the practitioner distrust the efficacy of ipecacuanha, it is quite open to him to add from fifteen to twenty grains of sulphate of zinc. If the administration of these agents is not quickly followed by vomiting and the expulsion of the membrane it is useless to repeat them, and even where the breathing has once been temporarily relieved by their use, it is very questionable whether they should be again employed. In no case should the physician place too much reliance upon them.

When it is judged that there is false membrane loose in the larynx, the removal of the membrane by direct mechanical means should be attempted. The best instrument used for this purpose is a brush attached to a piece of soft aluminium wire. Instead of the common laryngeal brush I use one made of squirrel's tail. *The hairs cover the sides of the laryngeal portion of the brush, and are directed upwards.* As the laryngoscope cannot generally be used, the brush, guided by the forefinger of the left hand, should be carried down into the interior of the larynx. The windpipe can generally be freed from exudation by to-and-fro movements combined with a certain amount of rotation. I have several times employed this brush with marked advantage. Even if the practitioner is successful, however, in detaching portions of membrane, fresh exudation often recurs.

I must here briefly refer to the subject of catheterism and "tubage" of the larynx. Catheterism was first recommended by Loiseau,¹ as a means of removing false membrane and introducing remedies into the windpipe. I have only to say that the false membrane can be much more easily removed with a proper croup-brush, and that solutions or powders can be more readily applied with a common laryngeal brush or insufflator. "Tubage," introduced by Bouchut,² consists in

¹ "Bull. de l'Acad. de Méd." 1857.

² Ibid. Sept. 1858.

the introduction of a small tube, from three-quarters of an inch to an inch in length, and leaving it in the larynx. It causes so much irritation that it cannot be retained, and its use has been quite given up.

It is at the close of the second stage of croup, when inhalations and emetics have failed, that tracheotomy is called for. Marked recession of the sternum and chest walls is the indication for its performance. The credit of having been the first to establish this operation on a secure basis as a justifiable part of the treatment of croup is due to Bretonneau,¹ who published his first successful case in July, 1825. Ten years later Trousseau² reported that he had performed the operation thirty-six times with nine recoveries. From this time the position of the operation was secured, and it has since been performed many thousand times in France alone. Before his death, Trousseau³ published a series of 466 cases in which the operation had been performed in the Children's Hospital in Paris, between the years 1849 and 1858. Of these, in spite of unfavourable surroundings, 126, or more than 1 in 4, recovered. Later statistics have given still more favourable results. In 1863, Fischer and Brieheteau⁴ collected all the facts within their knowledge at the Hôpital des Enfants Malades, the Hôpital Sainte Eugénie, and in the city and the provinces, and the general results were as follows:—At the Hôpital des Enfants Malades the operation had been performed in 1,011 cases, and the proportion of recoveries was 1 in 4; at the Hôpital Sainte Eugénie the proportion was 1 in 6; while the facts collected from other sources, though confessedly incomplete, showed in Paris 1 cure to 2·6 cases, and 1 to 3·6 in the provinces. According

¹ Bretonneau: "Mémoires" (New Syd. Soc.), p. 59.

² Trousseau: Ibid. p. 243.

³ Trousseau: "Rapport à l'Acad. de Méd."—"Bull. de l'Acad. de Méd." vol. xxiv. p. 112.

⁴ "Nouveau Dictionnaire de Médecine et Chirurgie." 1869, vol. x. p. 368.

to M. Sanné, however, who has published the most extensive statistics from the Paris hospitals, during recent years the proportion of recoveries after tracheotomy has been less favourable, especially at the Hôpital Sainte Eugénie,¹ as will be seen from the appended tables :—

HÔPITAL SAINTE EUGÉNIE.

Years.	Operations for Croup.				Proportion of Cures.
	Dis- charged Cured.	Dead.	Left uncured.	Total.	
1854....	2	7	0	9	1 in 4·50
1855....	4	9	0	13	1 „ 3·25
1856....	5	19	0	24	1 „ 4·80
1857....	5	24	1	30	1 „ 6·0
1858....	23	95	4	122	1 „ 5·29
1859....	17	88	4	109	1 „ 6·41
1860....	7	31	2	40	1 „ 5·71
1861....	16	45	3	64	1 „ 4·0
1862....	23	67	7	97	1 „ 4·21
1863....	35	68	3	106	1 „ 3·02
1864....	26	85	4	115	1 „ 4·42
1865....	44	87	6	137	1 „ 3·11
1866....	36	76	3	115	1 „ 3·19
1867....	29	63	4	96	1 „ 3·31
1868....	31	101	3	135	1 „ 4·35
1869....	31	70	2	103	1 „ 3·35
1870....	42	85	4	131	1 „ 3·11
1871....	12	78	3	93	1 „ 7·75
1872....	39	138	10	187	1 „ 4·79
1873....	32	170	11	213	1 „ 6·65
1874....	23	132	7	162	1 „ 7·04
1875....	27	175	9	211	1 „ 6·48
	509	1713	90	2312	1 in 4·54

¹ The results at this hospital for the first nine months of 1876 were still more unfavourable, the proportion of cures being only 1 in 8·31. This steady increase in the mortality after tracheotomy is attributed by M. Moizard (Thèse de Paris, 1876, No. 493), partly to the progressive extension of the operation to more and more hopeless cases, and partly to the more malignant character of the disease in Paris during recent years.

HÔPITAL DES ENFANTS MALADES.

Years.	Operations for Croup.				Proportion of Cures.
	Dis- charged Cured.	Dead.	Left uncured.	Total.	
1851....	14	17	0	31	1 in 2·21
1852....	18	43	0	61	1 „ 3·38
1853....	9	52	0	61	1 „ 6·77
1854....	14	29	0	43	1 „ 3·07
1855....	12	34	0	46	1 „ 3·83
1856....	16	33	3	52	1 „ 3·25
1857....	16	54	0	70	1 „ 4·37
1858....	34	73	2	109	1 „ 3·20
1859....	41	115	4	160	1 „ 3·90
1860....	24	101	3	128	1 „ 5·30
1861....	29	72	1	102	1 „ 3·49
1862....	27	112	6	145	1 „ 5·37
1863....	46	86	10	142	1 „ 3·08
1864....	40	105	8	153	1 „ 3·82
1865....	40	86	4	130	1 „ 3·25
1866....	27	71	3	101	1 „ 3·74
1867....	15	57	4	76	1 „ 5·06
1868....	26	36	0	62	1 „ 2·38
1869....	12	54	0	66	1 „ 5·50
1870....	21	43	0	64	1 „ 3·04
1871....	16	27	0	43	1 „ 2·67
1872....	30	71	9	110	1 „ 3·66
1873....	26	79	2	107	1 „ 4·11
1874....	23	81	4	108	1 „ 4·69
1875....	38	130	13	181	1 „ 4·76
	614	1661	76	2351	1 in 3·82

At the Hospital for Sick Children in the twelve years 1864 to 1876, sixty cases of croup and diphtheria were operated on. Of these thirteen, or 21·6 per cent., were successful. According to Krönlein's¹ recent statistics at the Hospital in Berlin the percentage of cures after the operation was 30·2² This was the result of 567 operations performed between January 1, 1870, and July 30, 1876, in Professor Langenbeck's clinic. By selecting the best individual series of statistics, for the most part from private practice, Dr. Solis

¹ "Langenbeck Archiv," Bd. xxi. hft. ii.

² See also Hüter: "Laryngotomie und Tracheotomie," Pitha-Billroth's Chirurgie, vol. iii. part i. Nro. 5, p. 26, et seq.

Cohen ¹ has brought together 166 cases of tracheotomy in croup with 110 recoveries !

Considering the enormous mortality of laryngeal diphtheria, even the most unfavourable figures prove that in such cases tracheotomy is not only justifiable, but that it is a positive duty. The chief questions to be considered in connection with the operation are what are the indications, and what is the best period for its performance ?

The cases most favourable for the operation are those in which the symptoms of general infection are slight or absent, and the strength of the patient is unimpaired. It is where the patient has still some vigour, where the pulse is strong and regular, the powers of assimilation good, and the asphyxia, though very marked, is not yet too advanced, that tracheotomy becomes most imperative. In such cases there can be no doubt that the operation has saved, and doubtless will still save, many thousands of lives. It is now generally admitted that tracheotomy should be performed without delay, as soon as it has become clear that it is impossible to relieve the asphyxia by other means. It is clear that an early insertion of the canula gives the patient a much better chance of recovery than when there is a long delay ; and it is owing to the disregard of this fact that tracheotomy in diphtheria has in some quarters acquired such an evil repute. For the description of the operation, and the precautions which must be taken in performing it, I must refer the reader to the textbooks on Surgery, but I would here call attention to the extreme importance of endeavouring, immediately after the operation, to draw out any loose false membrane, either with the croup-brush or an aspirator accurately applied to the mouth of the canula. The after-treatment is very important, and the patient requires most assiduous attention for some days. The temperature and due moisture of the room must be carefully maintained, the tube must be constantly watched, and freed from secretions or pieces of ejected

¹ "Croup in its Relation to Tracheotomy." Philadelphia, 1874.

membrane, and the wound must receive daily attention. At the same time the administration of food and stimulants must be the subject of the greatest care and regularity, and antiseptic sprays should be administered through the canula. The chief dangers to be feared in the after-treatment of tracheotomy are extension of the exudation into the bronchi, occlusion of the tube, and failure in the innervation of the lungs. The effects of extension of the membrane may in some cases be averted by removing the tube, and extracting fragments of lymph from the trachea with forceps, or with the eroup-brush. Long strips of exudation, and in rare cases almost entire casts of the windpipe have been removed in this way. Occlusion of the tube is only to be prevented by placing the patient under the charge of a trustworthy attendant, who will not fail in cases of emergency to remove the canula and free the passage.

In the third stage tracheotomy remains the only hope of saving the patient's life. If the operation has unfortunately not been performed in the second stage, the chance of success is very much diminished. The operation is not contra-indicated, however, even when the apnoea is extreme, and the patient is apparently on the point of suffocation, provided only that the heart's power is still good. In some cases the patient has been saved by it when literally at the last gasp. Such instances, however, are quite exceptional. Some authorities have maintained that even in quite hopeless cases, where the patient is dying from dyspnoea, tracheotomy should be performed with the view of promoting the euthanasia. It is true that death from syncope or gradual exhaustion is much less painful than death from apnoea, and it may be advisable to secure this substitution by a surgical operation. But it is not in these cases that tracheotomy finds its really valuable application. Further, when it is found on auscultation, that air enters one lung and does not penetrate the other, it is clear that the false membrane has extended down one bronchus, and tracheotomy is then much less likely

to be of any use. In the same way, if extensive pneumonia has supervened the operation is likely to be of little benefit. Where the patient is already dying of cardiac failure or exhaustion, it is of course in vain to attempt to save life by the surgical operation.

CHAPTER X.

NASAL DIPHTHERIA.

IN some epidemics of diphtheria the disease commences with nasal catarrh, and this phenomenon was so common in the epidemics witnessed by Bretonneau, that he regarded it as the ordinary course of the disease. Further experience, however, has demonstrated that catarrh of the nose is far less usual than it was at one time supposed, and that true nasal diphtheria is generally due to the extension of the plastic inflammation from the pharynx. The disease commonly first shows its presence by an unhealthy brown ichorous discharge, which causes abrasion, and even ulceration, of the skin in the neighbourhood of the nostrils. Soon afterwards the parts are covered with false membrane which can be seen extending through the nose. At other times the false membranes do not reach the external orifice, but, on using the speculum, a few scattered deposits of lymph can be perceived on the mucous membrane of the septum or the turbinated bones. The false membrane, however, is generally most abundant at the posterior nasal orifices.

In this form of diphtheria it is especially necessary to endeavour to prevent the products of the disease from accumulating and putrefying in the nasal cavities, for experience has shown that, under such circumstances, they are extremely liable to be absorbed and to lead to secondary septic poisoning. It is all-important, therefore, to keep the passages as clear as possible, by the use of astringent or solvent liquids. With this object, weak solutions of alum, tannin, carbolic acid, permanganate of potash, or lactic acid, should be repeatedly syringed over the affected parts. If epistaxis occurs, as it frequently does in nasal diphtheria, an astringent snuff or lotion is usually sufficient to arrest it. Plugging the nares should, if possible, be avoided.

CHAPTER XI.

SECONDARY DIPHThERIA.

WHEN diphtheria attacks persons already suffering from some other disease the new complaint is called "secondary diphtheria." The etiological influence of small-pox, measles, and hooping-cough was first noticed by Home,¹ and further observations have since been made by Peter, Sanné, Rauchfuss, West, and others. The following table, abridged from Sanné,² shows the diseases which furnish the greatest number of cases, but, as Sanné has pointed out, measles is a much more common disease than scarlatina, and in a given number of cases of each of these diseases, scarlet fever furnishes by far the larger number :—

Disease.	Cases.
Measles	137
Scarlatina	95
Hooping-cough	20
Typhoid fever	8
Small-pox	2
Nettle-rash	2
Bronchitis	4
Pneumonia	4
Pleurisy	4
Tuberculosis	19
Various cachexiæ (scrofula, chronic diarrhœa, &c.)	34
	<hr/>
	229

Secondary diphtheria³ is a characteristic phenomenon of *scarlatina maligna*. In these cases the common inflammatory

¹ Op. cit.

² Loc. cit. p. 353.

³ See Fuchs: "Historische Untersuchungen über Angina Maligna und ihr Verhältniss zu Scharlach und Croup." Würzburg, 1828.

pharyngeal lesion is more tardy in its appearance, and the patient often seems at first to be suffering from a mild attack of the malady. The disease generally attacks the pharynx about the ninth day, when the eruption has disappeared and the feverish symptoms have abated, and in a few hours swelling takes place in the glands at the angle of the jaw. The tonsils and fauces are covered with diphtherie exudation, a fetid sanious discharge proceeds from the nares, and the breath becomes tainted with a foul odour. The pharynx is nearly always the seat of the false membrane, and when the plastic exudation attacks the larynx, it is almost invariably by extension—not as a primary phenomenon. Out of 903 cases of scarlatina in the St. Petersburg Children's Hospital,¹ there were nineteen cases of pharyngeal diphtheria, and two in which the disease attacked the laryngo-tracheal membrane. The extension of the morbid process to the larynx, has been noticed to occur more frequently in some epidemics than in others. Gupp² described an outbreak in Würtemberg in which in the greater number of cases, croupy symptoms appeared from the third to the fourth day of the illness; and in some cases death took place before the exanthem appeared. As in primary diphtheria, on separation of the lymph, ulceration of the mucous membrane is often found. A characteristic specimen of ulceration (No. 36, Series W.) is contained in the Museum of St. Thomas's Hospital. The larynx, which was taken from an adult patient who died of scarlatina, has a very thin layer of lymph covering the entire mucous membrane, and the right arytenoid cartilage is laid bare by a large ulcer. Gangrene not unfrequently attacks the pharynx, larynx, and œsophagus, the pulse becomes weak, the surface of the body is blanched and cold, collapse supervenes, and the patient dies in a state of coma.³ In some cases large

¹ Rauchfuss: *Op. cit.* p. 154.

² Rühle: *Op. cit.* p. 243.

³ See Graves: "*Clinical Lectures on the Practice of Medicine.*" Lect. xxii. Dublin, 1848.

vessels are opened by the ulcerative process, and death occurs from hæmorrhage. A somewhat rare complication of the scarlatinal diphtheria requires some mention, *i.e.*, "scarlatinal buboes." The glands of the neck become suddenly inflamed about the tenth or twelfth day, and in five or six days a large abscess is formed.

In *measles* false membranes may become developed after the subsidence of the general pyrexia, and occasionally even gangrene of some portions of the pharyngeal tissues may occur.¹ Out of 1,176 cases occurring in the St. Petersburg Children's Hospital,² there were eleven cases of pharyngeal diphtheria, nine cases of pharyngo-laryngeal diphtheria, and thirteen in which the laryngo-tracheal membrane was the seat of plastic inflammation. Laryngeal diphtheria, or croup, is, however, much more common than pharyngeal diphtheria. "This variety of croup," observes Dr. West, "seldom begins until the eruption of measles is on the decline, or the process of desquamation has commenced. Its occurrence is most frequent from the third to the sixth day from the appearance of the eruption, but it oftener occurs at a later than at an earlier period."³ The prognosis is more unfavourable than in scarlatinal diphtheria, 80 per cent. of the cases terminating fatally.

Secondary diphtheria is not uncommon in *typhoid fever*, but from the unconscious condition of the patient it is very often overlooked during life, and only discovered at the post-mortem examination. Though it most frequently commences in the larynx, and is often confined to that part, the diminished supply of air causes little inconvenience, owing to the medulla having, to a great extent, lost its sensibility to impressions. The obstruction to respiration is also less marked, from the fact of the disease, in most cases, attacking adults. Diphtheria rarely occurs before the end of

¹ See Barthez and Rilliet: "*Traité des Maladies des Enfants*," Paris, 1853.

² Rauchfuss: *Loc. cit.* p. 153.

³ "Diseases of Infancy and Childhood." Sixth edition, p. 488.

the second week. The prognosis is most unfavourable, the unconscious condition of the patient preventing the use of antiseptic inhalations or local applications.

In *small-pox* diphtheria is seldom met with in this country. Rühle,¹ however, who witnessed a bad epidemic of small-pox in Greifswald, in 1856-57, and who made no less than fifty-four post-mortem examinations, observes: "Although I have seen here and there pustule-like elevations, I nevertheless consider the essential peculiarity of the laryngeal affection to be a eroupous or diphtheritic inflammation." This author adds that as "out of the fifty-four cases there was not a single instance in which the larynx and windpipe were in a normal state, he cannot but attribute a certain proportion of the mortality to the laryngeal affection." Pathological examples of the diphtheritic complications of small-pox are to be found in the museums of St. Thomas's and St. Bartholomew's Hospitals and in other collections.

In the nineteen cases of *tuberculosis* collected by Sanné (see page 99) every patient attacked died.

In the various acute and chronic affections in which diphtheria occurs the treatment, both local and general, must be the same as in the primary disease.

¹ "Die Kehlkopfkrankheiten." Berlin, 1861, p. 247.

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